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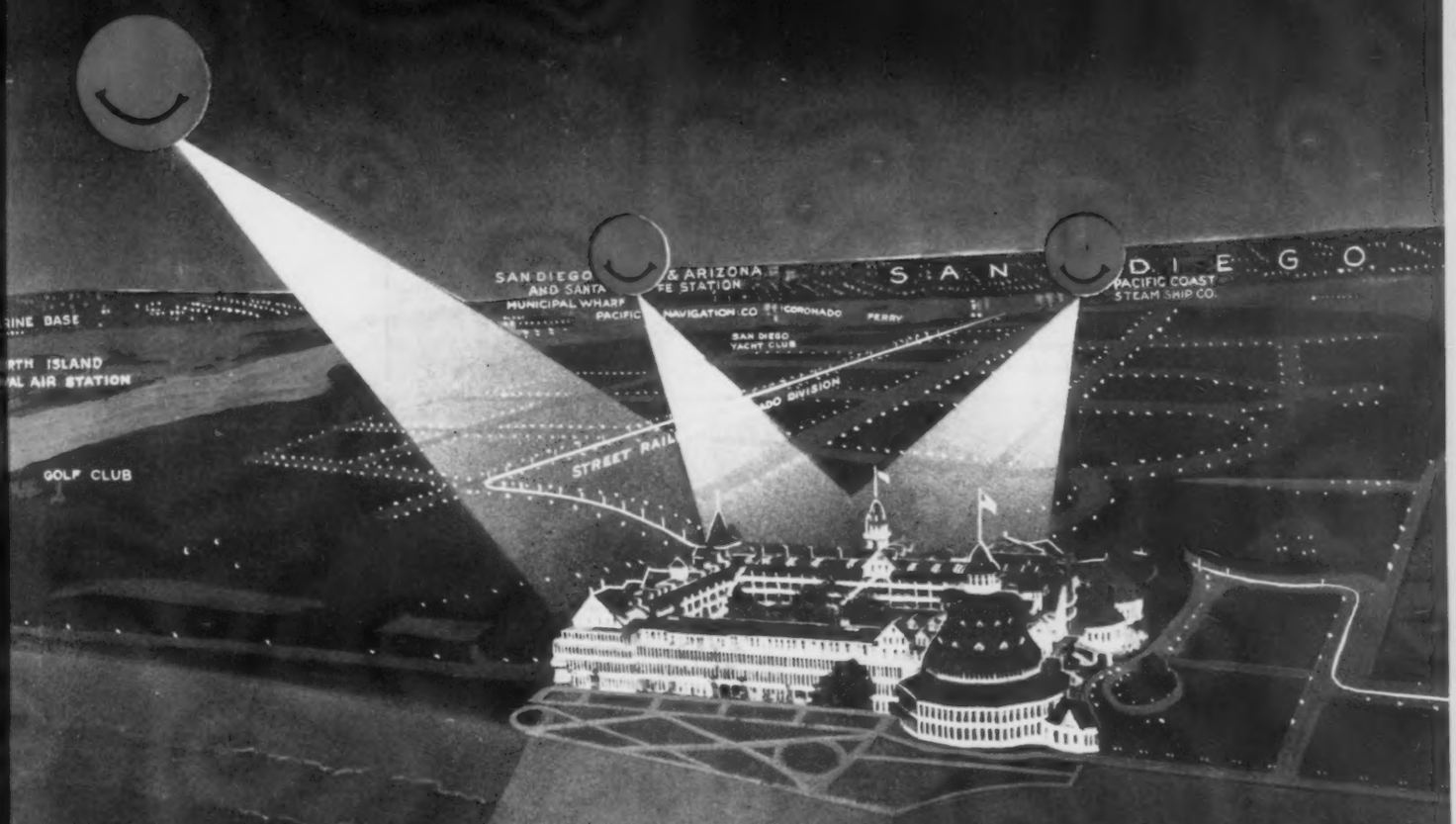

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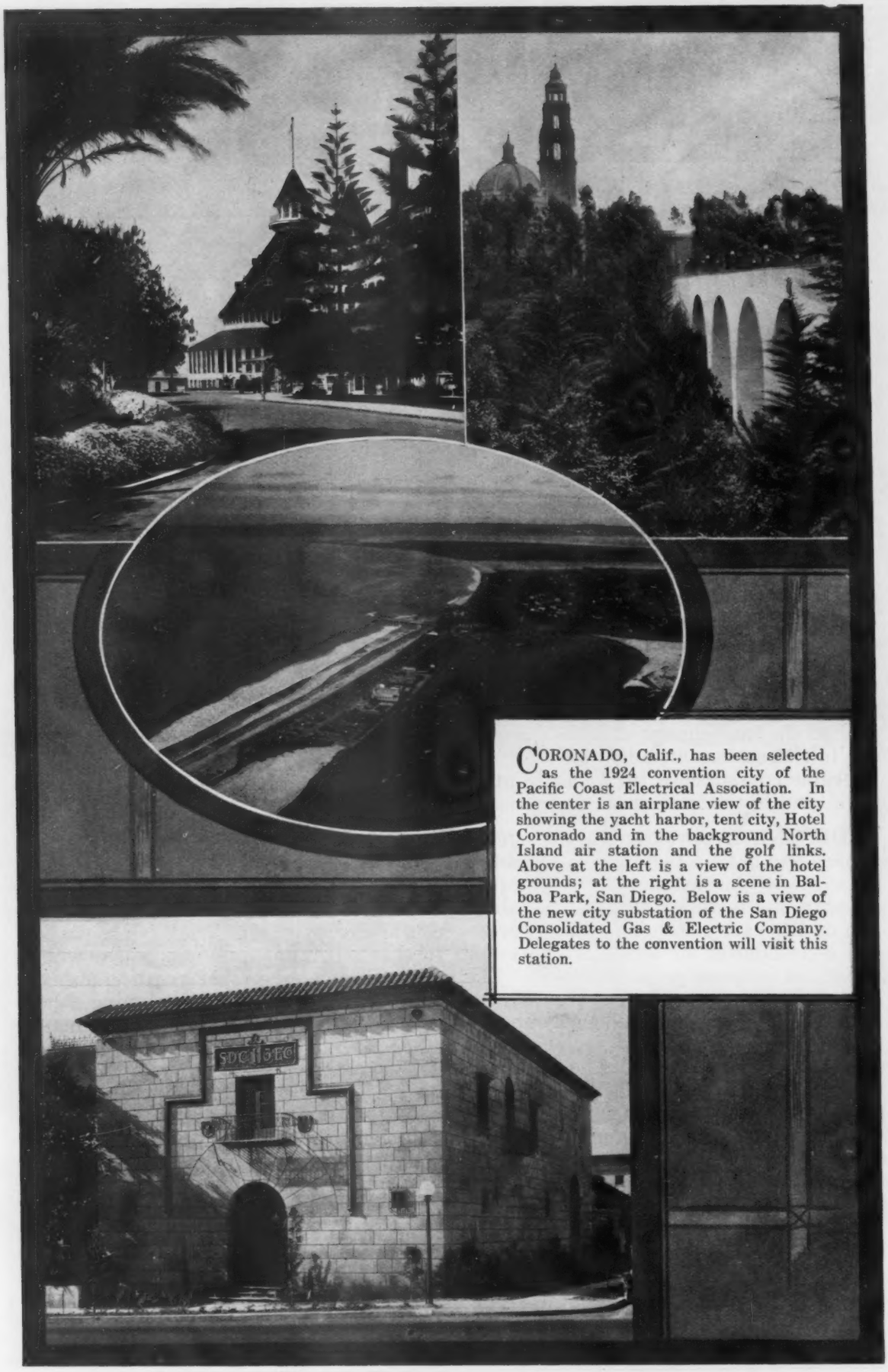
Co-ordination and Cooperation

EVERY year at this time it is the privilege of the Journal of Electricity to publish the committee reports of the Pacific Coast Electrical Association. Two or three weeks prior to the convention, copies of the Convention Report Issue are placed in the hands of every member of the Association, so that ample time is afforded for study and the preparation of discussion to be presented at the various section meetings. Thus papers are read by title only, and all of the time allotted to each committee session is given over to the interchange of ideas brought out in discussion, an advantage of considerable consequence to the convention itself, and to the industry as a whole.

INDUSTRIAL conventions are becoming more and more a factor in our business lives. As we develop mentally, as we progress in our material affairs, specialization on the part of the individual worker and consolidation of lesser into greater industries increase proportionately. The electrical engineer, as such, is still with us, but he is a specialist in some subdivision of the profession, rather than a general practitioner like the family physician of a generation ago. The central station that a comparatively few years ago served merely a small community, now, due to a combination of economic pressure and the evolution of events, numbers its employees by the thousands and its capacity in hundreds of thousands of kilowatts.

ON the one hand, is the individual whose scope of activity is narrowed more and more as it becomes confined to a single one of the countless problems of industry; on the other, his organization that is growing greater and greater in size as the years slip by. In this contrast lies one of the interesting phenomena of our industrial development. The problem confronting the executive is how to effect a real co-ordination of effort among an army of specialists, how to bring to each individual a sense of responsibility to the others, and an intelligent understanding of the effect of his work on the industrial structure as a whole.

THIS is the real function of the convention, which is merely an enlarged conference, after all. The day has passed forever when one man can be the whole show. No man, however great he may be or thinks himself, can be anything other than helpless without the aid of many others. Industry owes much, civilization owes much, to such institutions as the Pacific Coast Electrical Association, whose labors are dedicated to the accomplishment of real co-ordination, cooperation and the molding of the many individuals into a harmonious whole for the greater service of mankind.



CORONADO, Calif., has been selected as the 1924 convention city of the Pacific Coast Electrical Association. In the center is an airplane view of the city showing the yacht harbor, tent city, Hotel Coronado and in the background North Island air station and the golf links. Above at the left is a view of the hotel grounds; at the right is a scene in Balboa Park, San Diego. Below is a view of the new city substation of the San Diego Consolidated Gas & Electric Company. Delegates to the convention will visit this station.

Selling Electricity for Industrial Heating

By E. J. CIPPERLY*

THE application of heat materially affects cost and quality of practically every article manufactured today. In the past this important subject has received far too little attention by the industrial executives, and the possibilities of industrial electric heating often have not been given serious consideration.

The tendency on the part of most people has been, and this is still quite prevalent, to look only at the B.t.u. cost, when considering the use of electric energy for industrial heating, and from that standpoint, the extended use of the latter would be hopeless. The solution of the problem lies in selecting those processes where electric heat can be applied in such a manner that the total cost of the finished product is reduced, production is increased, or the quality is improved to an extent which will offset the higher cost of electric energy or results are attained that are impossible to secure with fuel.

It should always be kept in mind that on a given article the cost of the heating process through which it passes is, generally speaking, only a small part of the total cost of production of that article and, therefore, a slight increase in the cost of the heating process has very little effect on the cost of the manufactured article.

However, there are other advantages gained where electric heat is correctly applied, some of which can be measured in dollars saved, and others of a more or less intangible nature, the value of which is hard to measure. Examples of the former are the elimination or reduction of rejects, reduction of fire hazard, lower maintenance expense, less attendance, economy of floor space, reduction in power rate for other purposes, saving in first cost of piping, chimneys and ventilators, and other results which directly affect a reduction in the cost of labor operations through which the product later passes. Examples of the intangible savings are elimination of the personal factor, improved working conditions and convenience and cleanliness, resulting in more efficient labor.

A specific example of indirect saving resulting from the application of electric heating may be cited as follows:

A manufacturer of screws and tacks in drawing wire, annealed the latter between draws, after which it was necessary to pickle the wire, dip it in lime to counteract the acid, and then dry it in ovens heated by natural gas preliminary to the next draw. He electrified his ovens with the following results. He was able to dry out in three electric ovens an amount of wire which had formerly required the use of seven gas ovens, but further it was found that when drying in the electric oven, the lime on the wire did not form a hard glaze as it had in the gas ovens, and the resultant saving in wear of drawing dies, together with the increased production, gave a lower cost per ton although the electric energy cost more than the gas.

Many data have been published in the trade journals during the past few years relating to the use of electric ovens for japan baking; the repetition of some of these figures may be of interest. The manufacturers of automobiles are probably the largest users of japan in any one class of industry and they are, of course, vitally interested in such factors as cost of manufacturing, rate of production and quality of finish. The Chandler Motor Company found electric japanning ovens operated on a rate of 9c per kw. hr. about 20 per cent cheaper than ovens using natural gas at 30c per thousand cu. ft.

Tests made on two double ovens, one gas and the other electrically heated, showed the following results:—

Parts for 210 cars were baked in the gas oven with 18 per cent rejections—parts for 498 cars were baked in the electric oven with 3 per cent rejections. In other words, the electric oven gave over twice the output with one-sixth as many rejections.

*Sub-Committee on Industrial Heating: E. J. Cipperly, chairman; W. W. Hicks, R. C. Griffin, T. A. Reed, E. A. Wilcox, C. B. Merrick, Harry Kennedy, C. W. Curtis, F. O. Seviers.

Among other automobile companies using electric japan ovens such as Chevrolet, Grant, Peerless, Jordan, Maxwell, Packard and McCord, the rates paid for electric energy compared as follows with the rate of gas available:—

ELECTRICITY	GAS
2.4 c	80c
2.41c	35c
1.49c	35c
1.99c	35c
2.2c	49-79c
1.25c plus demand	59-79c
1.25c plus demand	49-79c

One automobile company reported baking in fifteen electric ovens in 9 hours, the same number of automobile bodies as were baked in another plant in twenty-four gas ovens in 12 hours, the ovens being of the same size in both cases. Put another way, 135 electric oven-hr. equalled the productions of 288 gas oven-hr.

A foundry company installed electric equipment in its core ovens and reduced the baking time one to three hours under that required with gas firing at 350 degrees F., which was the highest practical baking temperature with gas heating. The efficiency obtained with these ovens is from 10.9 to 14.5 lbs. of green cores baked per kw.-hr. consumed. In one week using four ovens 108,730 lb. of cores were baked with an energy consumption of 9,389 kw.-hr. or 11.6 lb. per kw.-hr.

Annealing glass X-ray tubes in an electric lehr resulted in a 20 per cent reduction in the overall cost of production as compared with the gas heat lehr. This saving is equivalent to seventy-five times the cost of the electric power used.

A manufacturer of enameled metal ware, who had used various fuel heated furnaces for firing vitreous enamel, installed an electric furnace of the metallic resistor type and after using the latter for several months, the superintendent reported as follows:—

"The results thus far obtained have been highly satisfactory particularly with regard to the quality of the output and the speed with which the furnace can be brought to temperature. The electric furnace can be brought from cold to 1,700 degrees F. in twelve hours. A coal furnace would require about three days, an oil furnace 24 hours and a gas furnace 16 to 20 hours.

"It is necessary to employ an expert fireman to keep the temperature at 1,700 degrees F. in the coal furnace and at times wind and atmospheric conditions make it impossible. But the most serious difficulty is with the muffle which periodically sags and breaks with resultant damage and loss of ware. The muffle must be renewed at intervals of two to twelve months, entailing a shut down of two to four weeks. Furthermore, with the coal furnace, the sulphur fumes are injurious to the ware and frequently cause a high percentage of seconds or job lots. The same drawbacks are experienced with oil and gas furnaces."

Automobile manufacturers are using the electric furnace for heat-treating crank shafts, axles, gears, drive shafts, springs, wrist pins, connecting rods, and cam shafts. They have found that ring gears passed through the electric furnace are not only of uniform hardness, but are free of warpage, such as is experienced with fuel heated furnaces. One manufacturer reports he has never had occasion to use his straightening machines.

Complete data are not available but it is estimated that the present connected load of industrial heating devices for temperatures up to 2,000 degrees F. is 400,000 kw.

Equipment is suitable for heating furnaces operating at temperatures up to 2,000 degrees F. The principal operations which are performed in the furnaces of the metallic resistor type are hardening, tempering, annealing, normalizing, carbonizing and baking vitreous or porcelain enamels. Electric furnaces of this type are being used for annealing brass, copper, aluminum, steel castings and various alloys and glass. They are being used for heat treating, i. e., hardening and tempering steel articles ranging from the ribbon spring which forms the motive power of the talking machine up to gun forgings weighing over 300,000 lb. The field of heat treating is very broad, practically every manufacturer who produces articles containing steel parts must have equipment for heat treating the latter.

The baking of vitreous enamel likewise takes in a large field as will be apparent upon considering the large number of articles in daily use which have an enamel covering.

The principal operations which are performed in ovens of sheet metal construction are core baking, drying, enameling, evaporating, japanning, roasting and tempering. Temperatures used for this class of work rarely exceed 700 degrees F.

The extent and rate of development of industrial electric heating will depend on the manufacturer of electric heating equipment, the central station and the local heating engineer. The increasing use of electricity for industrial heating makes it necessary that the men of these branches of the electrical industry know as much about the apparatus available and its application as they know about motors and lamps, which constitute the main load now carried by the central station. But it has been predicted by men of foresight that the industrial heating load will in a short time exceed that of the lighting and motor load combined. Industrial executives and engineers approached on the subject of electric heating, by power and sales engineers properly informed, will eventually think in terms of electric heat instead of other fuels that have been used in the past with all their disadvantages.

The industrial heating load is a very desirable load for central stations, and these companies should not overlook the possibilities offered and should have men in their organizations well informed on this subject.

Electrically Heated Cooking and Baking Equipment

By P. H. BOOTH*

IT is in its application to the industries that electricity has found its greatest field. One of the more recent devolpments in this industrial field is the utilization of electric current for commercial cooking and baking. Electricity, in an industrial sense, is some forty years old, but people have been so busy applying it to illumination, machinery and vehicles, that its wonderful capabilities as a producer of heat for cooking and baking have only been recognized during the last eight or ten years. The development in applying electric heat to what is known as heavy duty kitchen and baking equipment has naturally made the greatest progress where the energy charges are such that this application is practical and economical from the user's standpoint.

The Pacific Coast states, especially the State of California, has enjoyed a very low electric energy rate for a number of years, due to its tremendous hydro-electric power development. California, for instance, shows approximately 50 per cent of its industry electrified and the saturation increasing rapidly every year. Here we find the electric bread baking oven, the electric heavy duty range and many other items in commercial cooking equipment fast superseding fuel and gas types of equipment. These installations always breed success and satisfaction wherever placed and the users are always hearty endorsers of their equipment. There are so many advantages and compensating factors entering into the use of the electrically heated equipment that every day the user discovers some new saving, some improved working condition for his plant where electricity has solved the problem to make his bake shop or kitchen the last word in modern progress and development.

The electric heavy duty equipment allows the utilization of space heretofore not adequate for gas or fuel type equipment. The electrically heated units can be placed in any part of the building from the basement to the top story or in any remote interior location without disastrous effects to other parts of the building. There are no soot or grease deposits resultant from electric cooking. Electric cooking means a clean kitchen with pure air and healthy working conditions with only a limited amount of ventilation. Smoke flues and extra vents can be eliminated in new construction. Fuel storage is done away with. There is no firing or removing of ashes—consequently, less dirt and dust so prevalent with fuel type equipment. There are no explosions with the electrically heated units and fire hazard is greatly reduced. Insurance rates can be reduced eight per cent for the entire building where all electrical equipment is installed.

*Sub-Committee on Heavy Duty Equipment: P. H. Booth.

Next in importance in laying out or planning of the kitchen or bake shop, we find the utilization of floor space a most important factor on account of our rapidly increasing construction costs and here is where the electric equipment saves the user a very appreciable amount. Electric equipment has greater capacity per square foot of floor space used than any other type of equipment. We know that on one line of electric bake oven equipment, which is so successfully used in this field, that the capacity per hour runs approximately 50 per cent higher than the same rating of gas and coal equipment which the electric replaced.

To the user of electrical equipment there are many compensating factors which can be measured in a dollars and cents way and which are of the utmost importance. One of the most important factors is the saving in shrinkage in products baked electrically. It has been proved that ¾ of an ounce of dough is saved in baking one pound loaves of bread in a certain multiple deck type electric oven. All products baked electrically show a proportionate saving in shrinkage. Another important phase of the electric baking is less spoilage and the freshness retained in baked products for a longer period of time. Electric baking is always uniform, producing 100 per cent salable products at the top price.

In the electric heavy duty range we find the greatest improvement over any fuel type equipment through the development of cast-in helical core hotplate units for the cooking top. Here we find the demands of the most exacting chef met in a superior manner. This range cooking top is divided into four sections of four hotplates independently controlled with three heat switches for each plate. Each hotplate section can be readily heated to the hot spot temperature without heating the entire range. The helical core cast-in unit being the only unit which withstands the heavy duty service in a hotel kitchen—never warps or cracks. There is no distortion after heating to the hot spot temperature and quickly going to a low simmering temperature. This means an always level cooking top and increased efficiency for all surface cooking operations. It means that the chef can make his kitchen pay. It has solved the problem for the management in this respect.

The more important advantages cited by the users of electrically heated apparatus in general, compare favorably with those cited below and which are claimed for the electrical equipment:

1—Better and more uniform quality of product
2—Saving by less shrinkage
3—Goods baked electrically retain their freshness for a longer period, thereby reducing losses due to stale product
4—Saves ⅛ to ½ the floor space required for fuel fired oven.
5—Eliminates the often difficult and expensive problem of a furnace chimney
6—No labor to handle fuel or ashes
7—Eliminates constant provision for fuel
8—No dirt or dust from fuel
9—Can be installed on any floor of a building without bringing up the fuel handling problem
10—More uniform deck temperature
11—More accurate and flexible control of temperature
12—A reduction in most cases in insurance rates can be obtained for entire buildings in which complete electric heating apparatus is used instead of fuel fired apparatus.

Architects and builders particularly favor this later development in applying electric current to cooking and baking equipment as it materially assists them in their layouts and floor plans. There are a great many places where ordinances will not allow gas equipment to be used. Electricity has also solved this problem.

Where once used the electric heavy duty equipment is always favorably endorsed. The user knows that it has a great deal to do with the success of his hotel, restaurant or bake shop. It means the highest class cooking and baking for his establishment. Properly cooked food and properly baked products mean satisfied patrons. This news travels fast and is the best advertising a man can buy—the word of mouth advertising from pleased patrons. Poorly prepared food has just the opposite effect and creates a reputation hard to live down. That is why we can point to the users of electrically heated heavy duty equipment as being successful business men. There are no failures among them.

Architects and builders should profit by the experiences obtained where the electric equipment has been put to use and has so ideally served the hotel, restaurant or baker, the hospital, the school and the public institution. We are all interested in successful enterprise and there are no bounds to the wide diversity of the use of electric energy.

The Sale and Application of Electric Water Heaters

By J. M. MORRIS*

THIS year is the first in which a separate sub-committee on electric water heating has functioned. Unfortunately it was not possible for the committee to meet frequently enough to accomplish results that would otherwise have accrued from a more detailed study of this subject. Certain subjects, however, were discussed at the meetings which have general interest and which are contained in the following report.

Method of Increasing the Sales of Electric Water Heaters

It was felt by the committee that at the outset of the study under this heading it would be advisable to analyze the users of water heaters, grouping them according to certain classifications as follows:—

a. Domestic Application. This to include application of electric water heaters for residences.

b. Group Domestic Application. This to include application of electric water heaters to apartment house installations, bungalow courts, etc.

c. Commercial Application. This to include the application of electric water heaters to restaurants, film companies, barber shops, soda fountains, physicians, beauty parlors, etc.

d. Industrial Application. This to include the application of electric water heaters to manufacturing plants of all kinds.

Commenting on the classifications mentioned above the following facts are of interest. Considering the matter of domestic application for electric water heaters, the aspect of this phase of the business has remained, as in the past, the most important application for electric water heaters. During the year just completed numerous central stations carried on active campaigns among their customers, pointing out to them the advantages of electric water heating, and these campaigns resulted in considerable success. The point to be remembered in this connection is that, although the demand for electric water heaters on the part of the public is increasing, due to the increased use of these devices, nevertheless there is still considerable missionary work which must be carried on continuously toward increasing the popularity of electric water heaters.

Under the heading of "Group Domestic Application," a number of very large installations were made during the last year. One of these installations involved a total of seventy-six automatic heaters installed in a group of flat buildings in the city of Los Angeles.

Under the heading of "Commercial Application," there continues to be a demand for numerous special applications of electric water heaters in connection with restaurants, barber shops, etc.. These various applications would be too numerous to list in this report. A large number of these applications involve specially designed heaters.

In connection with "Industrial Application," we are not aware of any particular large application to include in this report.

Merchandising Channels.

Concerning methods of increasing the sale of electric water heaters, a study of the merchandising channels through which water heaters are being sold today would indicate that these channels are as follows named in order of their importance under present conditions in the State of California.

1—Central stations.
2—Electric dealers.
3—Apartment houses.
4—Industrial applications, including mines, industrial plants, etc.
5—Plumbers.

Distribution from the manufacturers through these various sources may be through a jobbing house or not, depending upon conditions.

As a first recommendation it is suggested that the list of distributing agencies mentioned above be studied over and that it be determined whether or not this list covers the situation or whether other means of distribution should be developed. It was suggested that the water heating and range committee give some thought to this subject along the lines of determining whether the electric industry is properly set up to develop the various lines of distribution as mentioned above. In certain territories today some of the above agencies are functioning to the exclusion of others. In connection with this situation it is suggested that it would probably be a very good thing for the electric industry if the situation were so handled that all of the above agencies would be given an opportunity to function in all of the territory involved. This means proper consideration of the price situation and proper education of the channels involved.

The interest taken in this problem by the various agencies mentioned above should be stimulated by pointing out what the proper development of this field means to them in their business. The central stations realize in a general way that the income from electric water heating is, usually speaking, extremely profitable. In this connection specific attention is called to a report of a survey made in the Pacific Northwest which survey was carried on by the Journal of Electricity and which appears in the October first issue of that paper, (1923). The following quotation is taken from that report:—

"In the case of revenue per kw. yr. it has been demonstrated by many western central stations that $9.50 is a fair average annual return to expect from each kilowatt of range load installed. This load occurring at off-peak periods, in the main, serves to fill in load valleys and to stabilize system load factors. In the case of water heaters the average annual return per kilowatt has been double that of a range. These two facts prove that here is a type of load which cannot be overlooked."

In order for the other agencies to be interested there must be a reasonable profit in it for them. Theoretically speaking, this profit should be in accordance with the amount of work or sales effort put forth by the agencies in question on electric water heaters. This subject is one which the industry will have to work out and which to some extent local conditions will influence.

Under the general heading of "Merchandising" it is recommended that an effort be made to bring electric water heaters more forcibly to the mind of the public by proper display. This can be done by means of display cards or preferably attractive water heaters displayed on the sales floor. This should be done particularly in those territories where conditions point to the possibility of building up a good business in the sale of electric water heaters. This idea, although not a new one to the industry in the sale of electric water heaters, is merely named as one which could be very much further developed than is the case at the present time.

Technical Data.

It was thought by the committee that in addition to reporting on the sales situation this committee should also carry on a study along the lines of preparing some useful information to the industry on the proper application of electric water heaters to various installations. This subject is a large one to cover in this report. It was thought, however, that it would be helpful to define briefly the various types of electric water heaters. With these definitions in mind it could be the work of a future committee to prepare a tabulation indicating the various types of heaters as particularly applicable to certain specified conditions.

Concerning the matter of heater control, there are two general classifications recognized by the trade today, namely, the automatic type and the non-automatic type. The automatic heater may be full automatic in that the temperature of the water is controlled by a heat controlled device, or thermostat, which automatically maintains the water at a certain temperature; or it may be of the protected type, in that a heat controlled device is furnished which automatically disconnects the heater from the line under abnormal conditions. The operation of the non-automatic reater is controlled entirely by hand.

*Sub-Committee on Electric Water Heaters: J. M. Morris, chairman; W. Wesley Hicks, G. L. Stannard, S. P. Russell, H. A. Mulvaney.

In connection with these divisions there are two further divisions known to the trade as circulating heaters and insert heaters. Circulation heaters are mounted as a unit external to the tank containing the liquid to be heated and heat the liquid by drawing the cold liquid from the bottom and delivering hot liquid to the top of the tank. Insert heaters are heaters designed to be applied directly in the tank or container. Another type which has come into use in some localities is known as the strap-on type which is designed to be strapped on the outside of the tank. In addition to these types there is a type known to the trade as the faucet type; a device applied directly to the faucet from which hot water is to be drawn.

It was not possible for the committee to go into a detailed study of the various applications and uses of the different types mentioned above so it will not be attempted to cover this phase of the situation in this report. As stated above this could be profitably carried on by a subsequent committee.

Electric Water Heaters in Residences.

Continuous hot water service once enjoyed at reasonable cost becomes one of the most indispensable conveniences of the modern home. A dependable automatic electric water heater renders a service superior to that supplied by the fuel heater both as to constancy of temperature and greater amount of hot water available instantly. It seems to be agreed in the industry that the water heater has helped to increase the revenue from electric cooking consumers with little if any additional transformer capacity. It is a well established fact that an automatic water heater of a relatively small capacity connected to well insulated boiler will supply perfect hot water service and show better load characteristics than any other class of domestic load. However, with the exception of a very few central stations the electric water heater operates on the cooking rate with the result that the average consumer who would prefer to keep the water hot using 400 to 1,000 kw.-hr. a month installs a relatively large water heater and heats water intermittently using only 150 to 300 kw.-hr., thereby keeping his bill within his budget at a loss to the power company of the revenue on 250 to 600 kw.-hr. a month to say nothing of the less favorable load characteristics.

The data secured from a number of typical installations indicated that most of the consumers who have an electric range and an electric water heater keep the water hot continuously where the rate is 1.6c or 1½c for the purpose and consume an average of about 500 kw.-hr. per month using heaters smaller than 3 kw. Where the water heater operates on a rate of 2c or more most of the consumers heat water only as required, using relatively large heaters for the purpose and only the unusual consumer maintains continuous hot water service.

Consumers maintaining continuous hot water service state that electricity at 2c per kw.-hr. costs about 33 1-3 per cent to 50 per cent more than gas costs at 90c per thousand cu. ft. Apparently the 1½c block of the cooking rate, with due regard to heater capacities and boiler insulation, can be depended on to double the revenue being received from the average electric cooking consumer without adding transformer capacity.

Electric Water Heaters in Apartment Houses

The application of standard power schedules to water heating in apartment houses, particularly block rates based on the demand, has served to emphasize the relatively large revenue per kilowatt of connected load that can be earned if due care is used in designing the system so that the relationship between water storage and heater capacity is correct. In one apartment house of fifteen apartments a central tank with two 6 kw. automatic water heaters uses over 7,500 kw.-hr. per month and earns a revenue of more than $100 per year for each kw. connected.

Following are the committee's recommendations:

(1) An electric water heater should be sold with every electric range.

(2) That water heaters with automatic control be recommended in every case. Where continuous hot water is to be maintained the thermostat functions to cut off the current when the contents of the tank have been heated to the desired temperature; where water is heated only as required or intermittently, the thermostat serves as a safety factor, turning off the heater in case it is forgotten.

(3) That 2 or 3 inches of good insulating boiler cover should be used and all the hot water pipes should be covered including the pipe between the heater and the tank.

(4) That a "U" trap be used at the top of the tank in the hot water line to keep the water from creeping up into the vertical lines and wasting heat.

The Promotion of Electric Range Sales

By P. H. BOOTH*

THE reports on electric water heating and commercial application of electric cooking equipment to hotels and restaurants are covered this year in separate papers, but the committee did not feel it advisable or opportune at this time to undertake a lengthy discussion on the electric range business.

A great deal has been said and many profitable discussions have been had in the past in connection with electric ranges so that the committee felt the subject has been so thoroughly covered that it would hardly be possible to add a great deal of value as the results of the past year's additional experiences in the electric range work. The committee held three meetings during the year, one in Los Angeles on Oct. 9, one in Fresno on Oct. 21 and 22, and one at Del Monte on Jan. 25 and 26. At these meetings the subject was covered in a very careful and thorough way from all its angles and a definite program formulated for the conclusion of the work of the committee and the presentation of a report on the electric range business. However, as the investigations proceeded, in our efforts to collect the required data outlined by the committee as being necessary and useful in the formation of the annual report, it was evident that the work of the range committee was duplicating in a small way the work of the national committee being carried on in a much larger and comprehensive form. All of the member companies on the Pacific Coast were being asked to supply the same information to the national committee that we would have required for our report. Realizing that the report of the national committee would be ready for presentation in advance of the meeting of this association, it, therefore, seemed advisable that we should not duplicate the work of the national committee, and we recommend, therefore, that the individual members of this association study most carefully and deliberately the report of the Committee on Electric Ranges of the national association.

This report of the national association is divided into two parts, the first, a study of the value of the electric range load to the central station. The research work in connection with this subject is being done cooperatively by the national association and the central station and others interested, and the Northwest Geographic Section of the national association. The other phase of the work of the national committee is the popularizing and selling of electric ranges. This subject is divided into six sections as follows:

(1) Engineering data manual
(2) Sales management manual
(3) Advertising manual
(4) Retail demonstrations and sales manual
(5) Water heating manual
(6) Servicing manual

These manuals are being prepared by the Society for Electrical Development in cooperation with the national association. These six subjects will be handled in manual form and will cover approximately the following:

1. Engineering data manual; giving transformer sizes, meter sizes, copper, and all information relative to the distribution and physical connection of the range to the supply circuits.

2. Sales management manual; to include methods of analyzing field, policies in regard to selling prices, installation charges, time payments, specialty sales efforts, campaigns, premiums, sales stimulation, examples of actual campaigns.

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*Sub-Committee on Electric Ranges and Water Heaters: P. H. Booth, chairman; O. E. Sholders, J. A. McWilliams, George T. Bigelow, J. W. Wrenn, H. K. Griffin, H. A. Cram, W. P. Schwartz, B. Y. Gibson, Milton Henoch, J. T. Deppe.

3. Advertising manual; to give the basic, underlying principles of a well rounded out advertising campaign, what can be accomplished by various advertising media, liberally illustrated with a concrete example of successful advertising.

4. Retail sales and demonstrators' manual; a manual showing the most effective methods and sales talk to be used by retail sales force in making sales to ultimate consumer and showing the methods to be employed by demonstrators both to prospective customers as well as to purchasers after the range is installed in the home.

5. Service manual; a manual giving information, ideas and suggestions regarding the proper organization of range service department including suggested records and stock to adequately serve customers.

6. Water heating manual; a manual giving comprehensive data regarding operation and installation, and desirability of water heater business, methods of promoting business, calculating installation, and data regarding the advantages of high and low water heaters.

It has been decided by the National Committee to defer the publication of the engineering data manual until after the conclusion of the investigations and surveys now in progress by the Northwest Geographic Section when more complete data will be available.

Quite aside from the work that the national association is doing and which the committee felt would be duplicated by our efforts in this territory, the electric range business during the year 1923, made very definite progress in the territory covered by this association. There were approximately 7000 electric ranges sold in the California territory, which is practically double the amount sold in 1922, and this result was accomplished by effective publicity through the consumer coupled with aggressive work on the part of the dealers and central stations in the sale and installation and the demonstration of these ranges. Practically all the installations for these ranges were made by the dealers as was a large number of the sales, indicating that as the range business develops and the ranges become more known and resultingly more popular with the general public an increasingly larger volume of range business will naturally be done by the dealers as they are the logical distributors of merchandise. It is very evident, however, that in the present status of the range business, the missionary work and the responsibility for overcoming the sales resistance on the part of the general public must rest largely with the central station.

Summarizing the above, therefore, it is the committee's belief that manuals and other knowledge available in pamphlets or book form will not sell electric ranges. It takes hard work and resourceful salesmanship to accomplish the desired result. Also the value of the electric range as a builder of satisfactory public relations should not be overlooked and the public can be sold the electric range idea in a more thorough way only when those in the industry themselves are alert to the value and the advantages of electric ranges by personal use in their own homes.

Commercial and Domestic Air Heating

By G. L. STANNARD*

THE principles of operation of the various types of electric heaters overlap to some extent but in order to avoid confusion these classes should be designated by distinctive names. These names, if standardized by the trade, would become familiar to the public and lead to a better understanding of electrical heating apparatus. In the interest of simplification we recommend that the following terms be used when describing types of electric air heaters:—

1. Reflector heaters
2. Radiant heaters
3. Convection heaters
4. Radiant-convection heaters
5. Indirect heaters
6. Central system heaters

Reflector heaters. This type of heater usually operates at a high temperature giving off radiant rays which are concentrated in one direction by means of a reflector. They are usually built in smaller sizes and are not suitable for general heating.

Radiant heaters are similar to the reflector type heaters but instead of the rays being concentrated in one direction they are allowed to spread, thus allowing a greater heating radius.

Convection heaters are those in which all the heat is absorbed by the air coming in contact with the heating elements, heating the room by means of the circulation of warm air rather than directing the heat on objects in the room. This type of heating will more uniformly heat every part of the room.

Radiant-convection heaters are a combination of the radiant and convection types. The air in the room is uniformly heated by means of the movement of hot air with the slight amount of radiant heat.

Indirect heaters are those in which the electrical energy is used to heat some substance which in turn transmits its heat to the surrounding air by means of radiation and convection. These heaters are generally of the electric steam-radiator type.

Central system heaters are those in which electricity is used in the central plant for heating air which is transmitted into the room through ducts or by some substance which is carried through the room in pipes which in turn heats the air in the room.

Size of Heaters

Great care should be taken in order to calculate the proper size of heater required for a certain room. This cannot be accomplished by guess as to a certain capacity for a certain volume as this can vary from ½ watt per cu. ft. to 3½ watts per cu. ft. according to the size of room and radiation losses. A heater which is too small for properly heating the room only makes a dissatisfied customer to the detriment of electric heating in general. The points to be considered in the heating of any room are as follows:—

1. Area of glass
2. Area, construction and exposure of outside walls
3. Area and construction of inside walls and nature of the adjoining room
4. Area and construction of floor, also a thorough understanding of the conditions under the floor
5. Area and construction of ceiling and whether with floor above or open attic.
6. Volume of air in room
7. Number of air changes per hour

The various manufacturers of electric heaters usually supply data for the calculation of heater sizes which should be carefully followed.

*Sub-Committee on Commercial and Domestic Heating: G. L. Stannard, chairman; E. A. Wilcox, J. C. Douglas, P. P. Pine, (Adolph Strauch, resigned), David Reed, J. T. Deppe, H. V. Mooney.

WATTS LOST BY RADIATION PER SQUARE FOOT SURFACE FOR DIFFERENCE IN DEGREES FAHRENHEIT BETWEEN OUTSIDE AND ROOM TEMPERATURE.

Nature of Surface	10°F	20°F	30°F	40°F	50°F	60°F
Single glass	3.0	6.0	9.0	12.0	15.0	18.0
Double glass	1.7	3.4	5.1	6.8	8.5	10.2
Single skylight	3.5	7.0	10.5	14.0	17.5	21.0
Double skylight	1.8	3.6	5.4	7.2	9.0	10.8
4 in. brick wall	1.9	3.8	5.7	7.6	9.5	11.4
8 in. brick wall	1.3	2.6	3.9	5.2	6.5	7.8
12 in. brick wall	.9	1.8	2.7	3.6	4.5	5.4
24 in. brick wall	.6	1.2	1.8	2.4	3.0	3.6
4 in. concrete wall	2.3	4.6	6.9	9.2	11.5	13.8
8 in. concrete wall	1.6	3.2	4.8	6.4	8.0	9.6
12 in. concrete wall	1.1	2.2	3.3	4.4	5.5	6.6
24 in. concrete wall	.7	1.4	2.1	2.8	3.5	4.2
Outside wall plastered and sided	1.3	2.6	3.9	4.2	6.5	7.8
Partitions lath and plaster both sides	1.0	2.0	3.0	4.0	5.0	6.0
1 in. wood partition	1.2	2.6	3.6	4.8	6.0	7.2
Wood floor (double board)	.25	.5	.75	1.0	1.25	1.5
Cement flooring	.9	1.8	2.7	3.6	4.5	5.4
Wood ceiling	.3	.6	.9	1.2	1.5	1.8
Plastered ceiling (floor above)	.75	1.5	2.25	3.0	3.75	4.5
Plastered ceiling (no floor above)	1.0	2.0	3.0	4.0	5.0	6.0
Air per 100 cu. ft.	5.4	10.8	16.2	21.6	27.0	32.4

Heat Lost by Radiation

The accompanying table taken from the best authorities gives the watts lost per square foot of surface for differences in temperature in degrees Fahrenheit between outside and room temperature.

In order to calculate the volume of air, multiply the volume of the room by the number of air changes required per hour.

Due to the impossibility of accurately determining the exact heating requirements of any building on account of the variation in construction, great care should be taken to study all conditions and to allow adequate safety factors. The following co-efficients must always be taken into consideration.

For sides exposed to winds add 10 per cent to 25 per cent radiation losses.

For buildings heated intermittently with long intervals of non-heating add 10 per cent to 25 per cent.

FOR EXAMPLE:—Suppose a room 15 ft. x 25 ft. with 9 ft. ceiling, two outside walls, plastered and sided, single glass area 80 sq. ft. wood floor. plastered ceiling, no floor above, one change of air required per hour, required to raise the temperature from 40 deg. F. outside to 70 deg. F. inside and having a temperature difference of 20 deg. F. between adjoining rooms. Refer to table column 30 deg. F. temperature difference.

Area	Watts lost per sq. ft.	Total watts lost
Glass	80 sq. ft. x 9	720
Outside walls	(15x25) 9 80 x 3.9	1,092
Inside walls	(15x25) 9 x 2.0	720
Floor	(15x25) x .75	281
Ceiling	(15x25) x .3	1,125
Air	(15x25x9) x 16.2	545
Total watts lost		4,483

Position of Heater

This matter should be given careful consideration. The proper position of heaters which circulate the air in the room is usually found to be directly in front of the windows so as to move the air from the window and not towards the cold glass which radiates the heat rapidly. The proper position, however, has to be sacrificed very often due to the architectural design of the room, the draping of the window and the placing of furniture. Filling the room with smoke and watching the air currents in the room will sometimes aid materially in determining the best location of the heater.

Automatic Heat Regulation

This can only be accomplished by some means which will automatically turn off and on a portion of the heater or the whole heater according to the temperature of the room. There are automatic heat regulators on the market at the present time which can be connected to any type of heater to automatically control the temperature of the room. Testing room temperature can be accomplished only by the use of accurate thermometers properly placed in the room. These thermometers should be suspended where they are not in contact with the walls or furniture but should be so placed that they are subjected to free circulation of air.

Report of Sub-Committee on Methods of Selling Electric Heating

In order to take up this matter fully it is necessary first to outline the channels through which this merchandise is sold as follows:—

1. Department store
2. Hardware store
3. Electrical dealer
4. Central stations
5. Electric heating specialists
6. Electric heating manufacturers

1. Department Store: Unless the department store has a separate department for electric heating, with salesmen who are competent to figure the proper size of heaters required for various rooms, it is unwise to encourage them in the sale of heaters larger than those which can be operated safely on the convenience outlet circuit, as they are not familiar with the wiring requirements, the proper capacities or the rates, with the result that the customer receives something that is unsatisfactory and continues to tell friends and acquaintances that electric heating is unsatisfactory. The improper selling of one heater very often puts a damper on the future sale of several heaters.

2. Hardware Store: This class of merchandisers generally follows along the same lines as the department store.

3. Electrical Contractor-Dealer: The electrical dealer has the greatest opportunity for the sale of electric heating because he not only receives his profit on the article but also has an opportunity for a good wiring job. It is true that only a small proportion of electrical dealers understand how to figure a heating installation but the manufacturers all employ competent engineers who are always willing to cooperate with the electrical dealer and give him advice on any installation that he might have a prospect for. A word with the dealers who are taking advantage of this service will convince them of the profit derived from this cooperation.

4. Central Stations: The majority of the central stations have recognized the advantage and possibility of electric heating and their commercial departments encourage the use and sale of these devices. The central stations recognize the possibilities of the increased load from this type of apparatus and they are only too willing to cooperate with all branches of the industry to further the sale of electric heating. The department store, hardware store and electrical dealer should be encouraged to use the service offered them by the central stations and manufacturers.

5. Electric Heating Specialists: These specialists devote their entire time to electric heating, engineering and sales. They have collected a large amount of data taken from actual installations and are prepared to furnish estimated costs of installations and operations based on conditions in various localities.

6. Electric Heating Manufacturers are interested in the sale of heaters through the above channels providing they can be sold properly to the satisfaction of the customer and offer all assistance possible for the furthering of sales.

Market for Electric Heating

1. Domestic heating
2. Commercial domestic heating
3. Commercial heating

Domestic heating includes room heating for homes and flats.

Commercial domestic heating includes room heating for apartment houses, hotels and clubs.

Commercial heating includes office buildings, business buildings, schools, churches, banks, manufacturing plants, etc.

General Information

1. Cost of operation
2. Cost of installation
3. Installation
4. Maintenance of electric heaters
5. Safety of electric heaters

1. In the majority of cases that have been investigated the opinion the public now has that electricity is expensive for heating, has been the outcome of improper installations, due to the fact that they were sold heaters of insufficient capacity to do the work properly and that the heaters were being used on the lighting rate instead of the heating rate. The success of selling electric heating is not merely in selling a heater, but to properly instruct the party that is purchasing the heater exactly what its capacity for heating is and the rate that is available. Considerable difficulty in this respect would be overcome if the manufacturer would place a tag on each heater as follows: "See your power company for special rates on heating." The average monthly bill for electric heating usually is larger than that for other fuels on account of it being so convenient that it is used much more than other heating systems would be used. To the monthly bill for other fuels must also be added, before a comparison can be made, the extra cost for cleaning, tinting, painting, papering, etc. that would be necessary.

2. The cost of electric heating installations is not excessive compared with the installation of other heating systems, providing exactly the same results are given as would be obtained with other heating systems. In many cases the cost is much less. In a new building it will be found that by taking into consideration the elimination of all flues, chimneys, boiler rooms and other safety factors that have to be installed with other heating systems, the cost of the installation of electricity is no greater.

3. Effort should be made to prevent improper installations which have been the cause of unsatisfactory heating.

4. The maintenance of electric heating devices is much lower than that of those using other fuels.

5. The use of electric heaters approved by the National Board of Fire Underwriters reduces fire hazards.

Channels Through Which Electric Heating Should Be Encouraged

1. Owners of the homes
2. Owners of apartment houses, hotels, office buildings, theaters, etc.
3. Clubs, halls, churches, schools, etc.
4. Architects
5. Building contractors

1. There is a large opening for electric heating in the home. There are enough installations at the present time so that concrete data can be obtained as to operating costs, etc. Proper heating in the home is the opening wedge to heating in other buildings.

2. Numerous apartment houses, hotels, office buildings, theaters, etc. are being heated electrically at present with entire satisfaction to the owners and tenants. One of the main features in electric heating for this type of building is the flexibility under which it can be operated. In many cases the owner purchases electricity on a master meter thus earning a low rate and submeters it to the tenants.

3. Where electric heating is used in clubs, halls, churches, schools, etc. it is opening up a great field to the home user. When comfort is brought to the public in this way it convinces as to the results that can be obtained with a proper electric heating system.

4. Architects as a rule are averse to recommending any system of heating to their clients until such time as it has been thoroughly tried out. Many installations have been made by architects in their own homes for heating, with the result that they are specifying this method of heating to their clients. It should be the special effort of all branches of the electrical industry to furnish data to architects so they will be in a position to recommend electric heating to their clients. In general the client relies entirely on the architect. Even if other heating systems are installed, it is often possible to convince the architect of the advisability of placing heating plugs in the main rooms for use during the time that the central system is not in operation.

5. The building contractor should be advised to put in a main service of sufficient capacity to take care of any future heating requirements. This can be put in at a small cost during construction and prevents the necessity of defacing the building later with a large service pipe. The building contractor should be encouraged to:

1. Install large service conduit
2. Install service wires and main switch of sufficient capacity
3. Install heating plugs in main rooms
4. Install complete heating system

As the advantage of electric air heating is becoming better known, augmented by the satisfactory results obtained by present users, it is leading to the favorable acceptance of this method of heating.

It is the recommendation of this committee that thought be given to the establishment of a school of heating under the jurisdiction and control of the Pacific Coast Electrical Association; classes to be held by persons capable of imparting correct information on electric heating. These schools should be held in the larger cities in the territory of the Pacific Coast Electrical Association and should be open to the sales force of all merchandising channels.

Sub-Committee to Collect Data on Electrical Heating Installations

Data on the cost of installation and operation of electrical heating equipment must be very carefully compiled and more carefully used in order that it may not be misleading. Each case of heating has special features, which must be considered.

The present status of connected load of electrical heating was not investigated as most of the domestic installations are metered together with cooking and water heating load, and any comprehensive segregation of connected heating load is difficult to obtain. From manufacturers' statements, the increase of electrical heating during 1923 over the 1922 figures was probably 300 per cent, or about the same increase as 1922 showed over 1921. Instead of attempting to check this growth it was deemed more valuable to study the fundamentals of the heating problems, and put them in shape so they might be used by salesmen or others in the electrical industry. With such a subject, and with so many variables, the biggest difficulty is to present a tangible idea to the general public. Therefore, this problem was attacked from a study of the results desired. It was thought that the attached comparative curves would put the story across to the electrical trade and they in turn must pass the story on. The subject was studied from the angle of special installations, attempting to find a basis of comparison between them or classifying the controlling factors so that the data gathered will emphasize the important points and can be used with as little variation as possible. The curves of use show the kw.-hr. consumption only, as the varying rates introduce further complications. The average cost, for heating only, usually lies between 1½c and 2½c per kw.-hr.

If properly applied, the possibility of electric heating represents a large field of use for the public utility and a big potential market for the manufacturer of heating equipment. The dangers of misapplied heating are large enough that every available improvement should be made and advantage taken of all possible conservation features.

Variables

Many variables enter into consideration of heating problems.

1. Weather conditions.

A prominent manufacturer of ventilation equipment states:

"In the United States 70 deg. F. is generally considered the most suitable temperature for a heated building. It should be noted, however, that temperature is not the only factor that causes a feeling of comfort or discomfort, since the relative humidity is also a determining factor. It has been recognized for years that air of very low relative humidity gives a feeling of coolness as compared with air of high relative humidity at the same temperature. With the air moving at a noticeable velocity the difference is more pronounced.

"The Chicago Commission of Ventilation thoroughly investigated this subject and worked out the relation of temperature and humidity over a range of degrees that covers what they have named the "Comfort Zone." This zone and others that are designated as "Too Warm" or "Too Cold" are shown on the chart below. From their investigations the comfort line, when plotted against temperature and humidity, is represented by the equation R = 315 — 4T, where R is the relative humidity and T any temperature above 55 deg. F. shown on the chart.

"From the chart it will be seen that, at 70 deg. a relative humidity of 36 per cent tends toward the most comfortable feeling. It has been found by investigators that at 70 deg. from 35 per cent to 40 per cent is the most desirable humidity, yet in most heating specifications issued, and in the majority of recommendations made, a relative humidity of 50 per cent is called for. This is too high and causes a feeling of oppressiveness which would not exist if the relative humidity were reduced to 40 per cent. Aside from the comfort, it will be found difficult in most buildings to keep the windows clear of frost and condensation with high humidity during the coldest weather.

"A further consideration is the cost of adding to the air the moisture necessary to give a resultant high humidity. To add three grains of vapor per cu. ft. of air, as generally necessary to maintain this condition, requires the transference of 465 B.t.u. per thousand cu. ft.

"As seen in the chart, there is a considerable range of temperature with its corresponding proper humidity."

NOTE: 465 B.t.u. is equal to 465/3412 kw.hr. When it is considered that air at 30 deg. temperature and having a relative humidity of 75 per cent will have a relative humidity of only 18 per cent when heated to 70 deg. it is readily seen from the comfort charge (Fig. 1) that with this humidity a temperature considerably above 70 deg. will be required to make the room feel as warm as it should be. This excess temperature increases the radiation and air change losses and therefore means more costly heating. It will, therefore, be seen that an intermediate point can be located at which the best economy is obtained.

2. Hours of heating per day, or night.

Night heating is apt to be considerably more expensive than day time heating due to the daily variation in temperature.

3. The use of the building, number of occupants and their activity.

Each grown person under normal activity is equivalent to approximately 200 watts. Their rate of activity either increases or decreases this amount. Where large

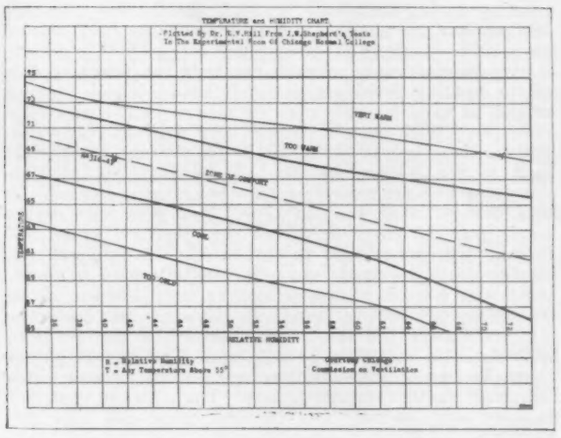
TEMPERATURE and HUMIDITY CHART
Plotted by Dr. E.V.Hill From J.W.Shepherd's Tests
In The Experimental Room of Chicago Normal College
TEMPERATURE
RELATIVE HUMIDITY
R = Relative Humidity
T = Air Temperature Above 55°
Shaded Enclosed Area Comprises Conditions
Considered as Ventilation

Fig. 1.—Comfort chart showing temperature and relative humidity.

numbers of people are congregated in a comparatively small space it is readily seen that they constitute a considerable item of heat introduced into the room. In addition to the heat furnished the room in this way, the greater the activity of the people the less they notice a sub-normal temperature.

4. Type of construction, materials used and exposure.

All of these items greatly improve the economy or waste of heating and with the present type of construction there is material room for advancement along this line.

In order to get a comparative basis for costs in California, curves have been plotted (Fig. 2 and Fig. 3) to show daily and yearly average conditions for three localities:—Los Angeles, San Francisco, and Fresno. Also, wherever data were available, curves have been plotted to show the consumption by months for various conditions of use and construction such as:

Residences	Fig. 4
Apartments	Fig. 5
Schools	Fig. 6
Churches	Fig. 7
Dance halls and theaters	Fig. 8
Hotels and hospitals	Figs. 9, 10
Businesses	Fig. 11

By segregating the consumption under these various classifications into the (1) losses due to radiation, (2) to the changes of air, etc., these varying, of course, with the (3) size and type of building, the (4) number of people present and their activity, it is hoped that the largest losses in electric heating will be located, and concerted effort can be made to reduce these losses and thereby increase the potential field of use.

To illustrate the fundamental differences in heating conditions, compare the typical bungalow room of 15 ft. x 25 ft. x 10 ft. with a theatre building for 590 seats, having dimensions of 36 ft. x 112 ft. x 24 ft.

Case I—Bungalow room (40° outside temp.)

	Area sq. ft.	Watts loss per sq. ft. at 30° temp. diff.	Watts Required
Windows	100	9	900
Ceiling	375	3	1125
Floor	375	0.8	300
2 inside walls	400	3	1200
2 outside walls	300	4	1200
Total radiation losses			4725
One air change per hour* requires			607
Heat generated by two people			400

$$\text{Ratio} \frac{\text{Radiation losses}}{\text{Total losses}} = \frac{4725}{5332} = 89 \text{ per cent.}$$

(*Sufficient for two people:—1800 cu. ft. per hour per person is recommended for homes. In threatres, churches, etc., 1000 cu. ft. is the figure used).

Case II—Theatre building.

	Area sq. ft.	Watts loss per sq. ft. at 30° temp. diff.	Watts Required
Ceiling	4032	3	12096
Floor	4032	1	4032
4 Walls	7104	4 (8 in. brk)	28416
			44544 kw.
100 cu. ft. of air each for 500 persons requires .0054 × 30° x 500,000 =			81,000 kw.
Heat generated by 500 people =			100 kw. equiv.

$$\text{Ratio of} \frac{\text{Radiation losses}}{\text{Total losses}} = \frac{445}{1255} = 35 \text{ per cent.}$$

From these approximate calculations it is seen that without considering the large heating equivalent of the persons in the theater, the radiation losses are a minor

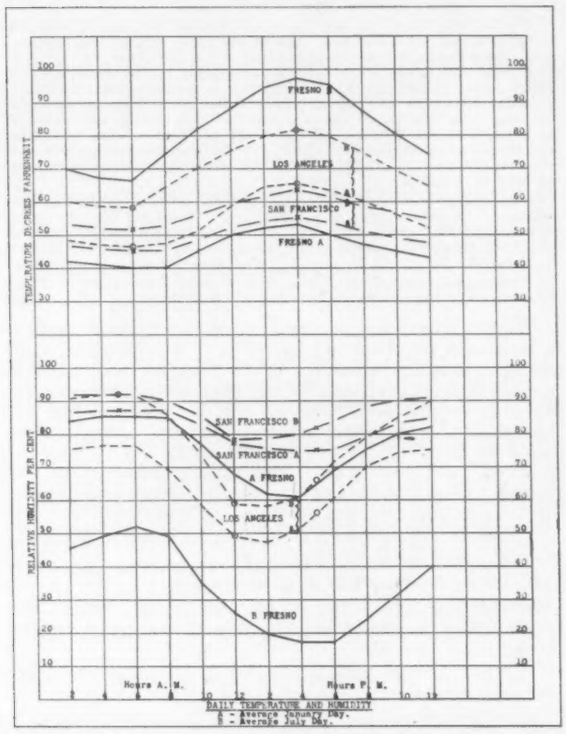

Fig. 2.—Curve showing average daily temperature and humidity for three cities on average January and July days.

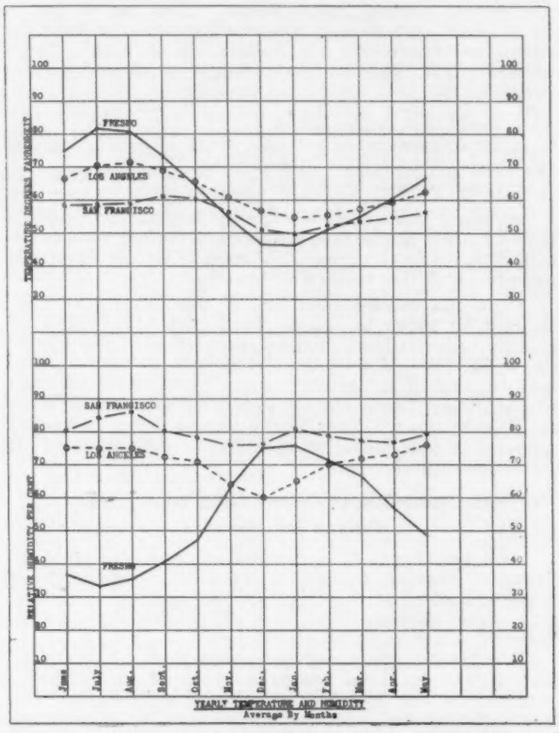

Fig. 3.—Curve showing yearly temperature and humidity for three cities.

factor in such an installation instead of decidedly a major factor as in bungalow heating. Therefore, the theater heating problem centers on the necessary heating of the building before the audience arrives. In the same way apartment heating is found more economical than individual residence heating.

Conclusions and Recommendations

It is the opinion of this committee:—

1. That there is a big potential possibility in the electric heating load.

2. That it is already a large industry and will continue to grow even without assistance from the electric utilities as a whole, but if properly studied and encouraged for its most profitable applications this potential field can be materially enlarged.

3. That the weather conditions in any particular locality must be thoroughly studied in order that proper installations will be made.

4. That every possible conservation should be made in building construction in order to improve heating conditions and thereby improve the economic possibilities of electric heating.

5. The aims and purpose of this paper will have been accomplished if the one thought is left in the reader's mind that the heating problem is one which cannot be dismissed as a simple subject, but that if a thorough study is made, many possibilities for advancement are open. Careful consideration should be given to all the factors influencing each of the consumption curves included in this paper.

APPENDIX

Residence Consumption

Berkeley Residence—H. J. Gute, Northbrae.

Electric Range	8 kw.
Water Heater	6 kw.
Air Heaters	23 kw.
Total	37 kw.

Probable consumption is 375 kw.hr. per month.

Fresno Residence—A—7 Room Aeroplane Bungalow, 1562 Roosevelt.

Electric Range	5 kw.
Water Heater	3 kw.
Air Heaters	4 kw.
Total	12 kw.

Probable consumption is 325 kw.-hr. per month.

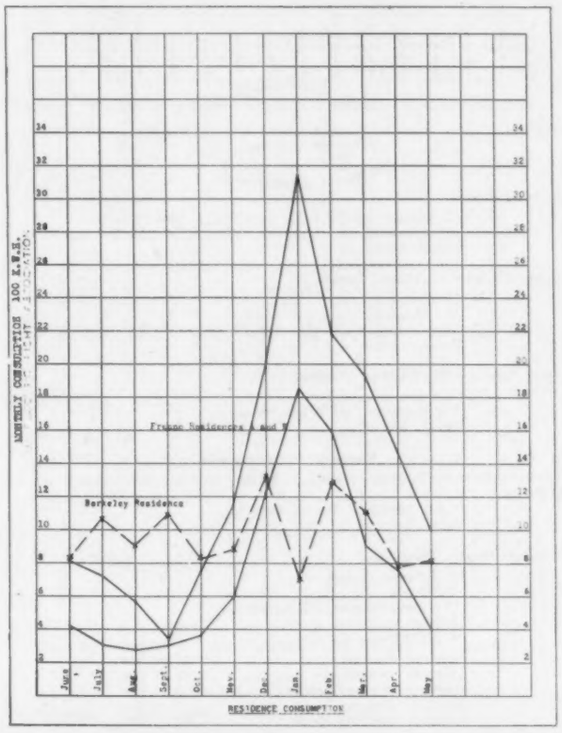

Fig. 4.—Curve showing residence consumption by months.

Fresno Residence—B—6 Room Bungalow, 3347 Mono.

Electric Range	7 kw.
Water Heater	5 kw.
Air Heaters	4½ kw.
Total	16½ kw.

Probable consumption is 375 kw.-hr. per month.

Apartment Consumption

Oakland—Merritt-Grand Apartments, Frame Stucco Building. 16 Four Room Apartments.

13 Air Heaters, 2 kw.	26 kw.
12 Air Heaters, 1 kw.	12 kw.
Total	38 kw.

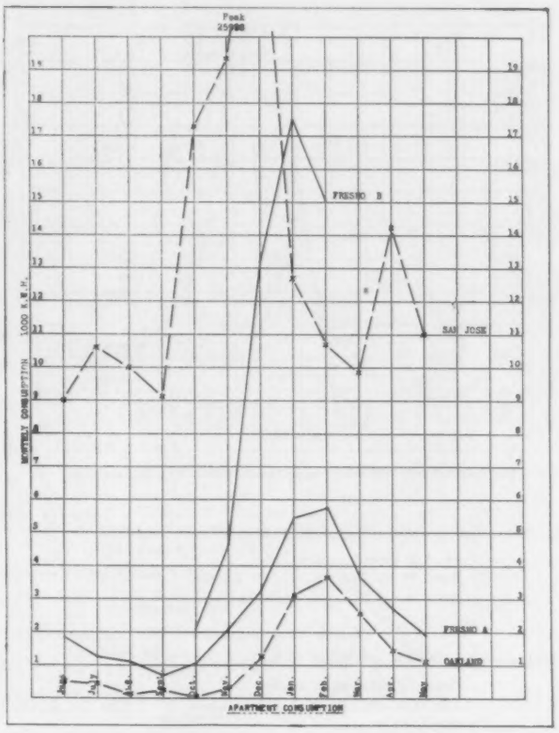

Fig. 5.—Curve showing apartment house consumption by months.

San Jose—Fredson Apartments.
15 Air Heaters, 3 kw. ..... 45 kw. (approx.)

Fresno—Jorgensen Apartments—A—8 Apartments, Frame Building, each having

Electric Range	5.54 kw.
Water Heater	3.00 kw.
Air Heater	3.00 kw.
Total	92.32 kw.

Probable consumption is 1600 kw.-hr. per month.

Fresno—Nelson Apartments—B—8 Apartments, Frame Building, Each having

Electric Range	8.16 kw.
Water Heater	3.00 kw.
Air Heaters	5.00 kw.
Total	129.28 kw.

Probable consumption is 2400 kw.-hr. per month.

School Consumption

Berkeley—Cora Williams Institute.
10 Rooms, 31 x 35 ft.
Hall, 40 x 40 x 22 ft.
Guest Room 10 x 12 ft.
Air Heaters, 55 kw.

Esparto—High School.
44 Air Heaters, 188.5 kw.
Average monthly consumption, 3360 kw.-hr.
Maximum demand of 128.7 hp.

Elsinore—Grammar School.
Air Heaters, 99.8 kw.

Burbank—Abraham Lincoln School.
Stucco Building, 145 x 52 ft. and wing 36 x 40 ft.
Five rooms.
Air Heaters, 13 of 5.28 kw. each.
Total, 68.64 kw.

Clarksburg— Grammar School. (New.)
98 kw.

Sacramento—Riverside School. (New).
98 kw.

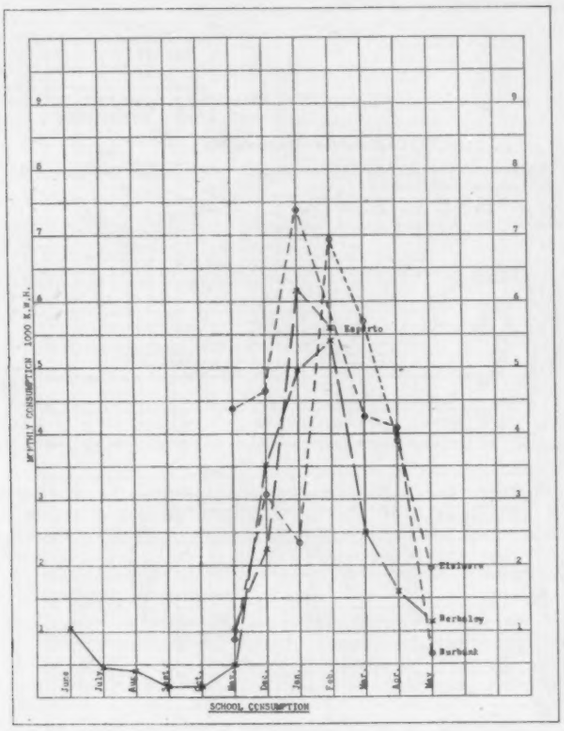

Fig. 6.—Curve showing school consumption by months.

Modesto Junior College (approx. 2 heaters per room)

52 Air Heaters, 290 kw.
Nov. 28 to Dec. 31, 18,000 kw.-hr.
Dec. 31 to Jan. 30, 23,000 kw.-hr.

Church Consumption

Oakland—3rd Church of Christ Scientist.

Frame Building, 3 rooms.
Air Heaters, 10 of 3.3 kw. each, 2 of 2.69 kw. each.
Total, 38.28 kw.

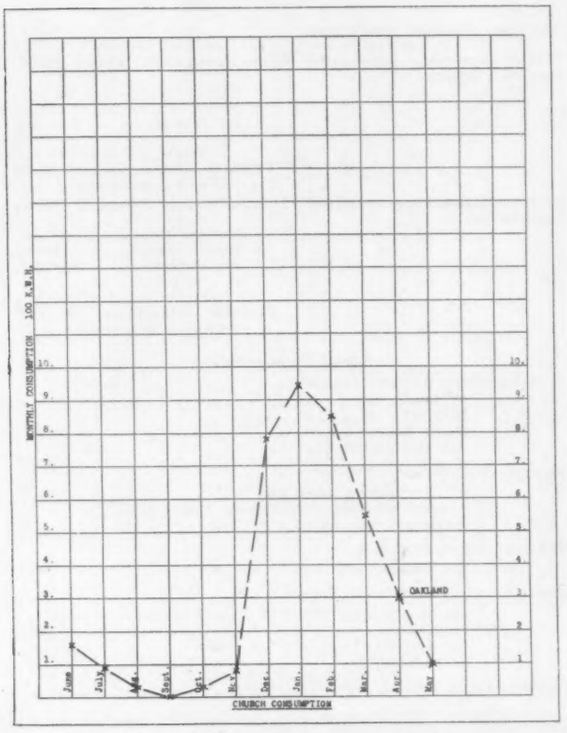

Fig. 7.—Curve showing church consumption by months.

Theatre Consumption

Modesto—Richards Theatre.

Motion Picture Theatre—Capacity 900 persons.
Air Heaters, 96 kw.
Note: Consumption available for one month only.

Fresno—White Theatre.

Capacity 1,400 persons.
Air Heaters, 125 kw.

Fresno—Severance Dancing Academy.

Stucco Building with Large Window Space.
Ball Room 82 x 45 x 15 ft.

Water Heater	2 kw.
Ball Room Air Heater	24 kw.
Other Air Heaters, 3—	2 kw.
1—	1½ kw.
Total	30½ kw.

Classes are held on an average of two per day, one in the afternoon and one in the evening. Evening parties are frequently held, which, of course, last longer than the dancing classes.

El Centro—Valley Theatre.

6 Air Heaters, 26 kw.
No operating data available.

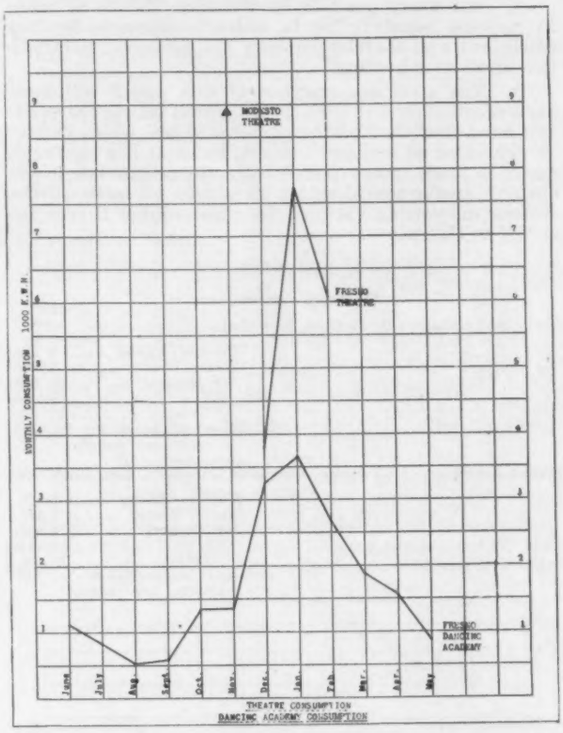

Fig. 8.—Curve showing theater and dancing academy consumption by months.

Hotel Consumption

Merced Hotel.

62 Rooms, 10 ft. x 12 ft. x 10 ft. and lobby.
Air Heaters, 62 of .96 kw. each, 4 of 1.44 kw. each.
Total, 65.28 kw.

Paso Robles—A—Hotel Taylor.

20 Rooms.
Air Heaters, 20 1 kw. each.
Also 5 kw. Water Heaters.
Total, 25 kw.

Paso Robles—B—Hi-Way Annex.

28 Rooms.
Air Heaters, 28 2 kw. each.
Total, 56 kw.

Hospital Consumption

Visalia—Tulare County Health Center Clinic, One story brick building.

9 Air Heaters, 6 kw. each.
Total, 54 kw.

Merced—Mercy Hospital.

12 Private rooms
3 Wards.
7 Nurses rooms (Quarters).
1 Nurses living room.
6 Miscellaneous rooms.

Electric Range	22.00 kw.
Electric Sterilizer	15.58 kw.
Electric Water Heater	10.00 kw.
Electric Range	3.00 kw.
Electric Air Heaters	64.90 kw.
Total	115.48 kw.

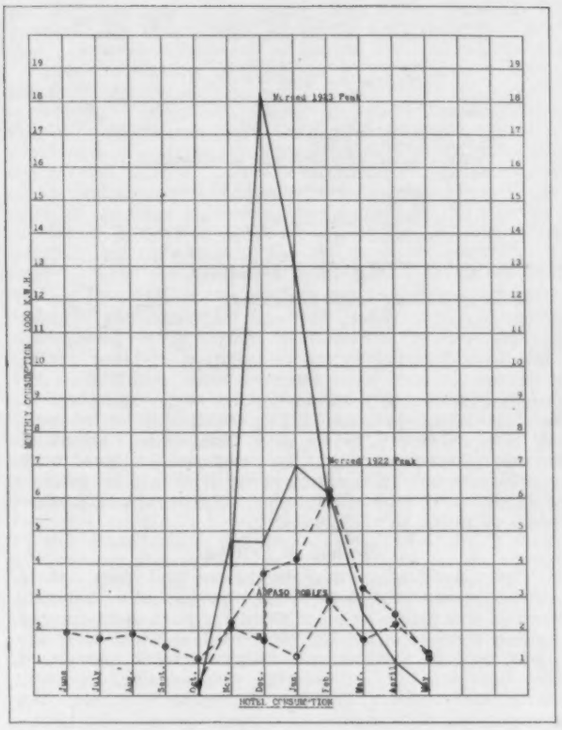

Fig. 9.—Curve showing hotel consumption by months.

Fresno—Union Hospital.

One Story Concrete Building.
16 Private Rooms
4 Miscellaneous Rooms.
Electric Range, 13 kw.
Water Heaters, 20 kw.
Air Heaters, 19.32 kw.

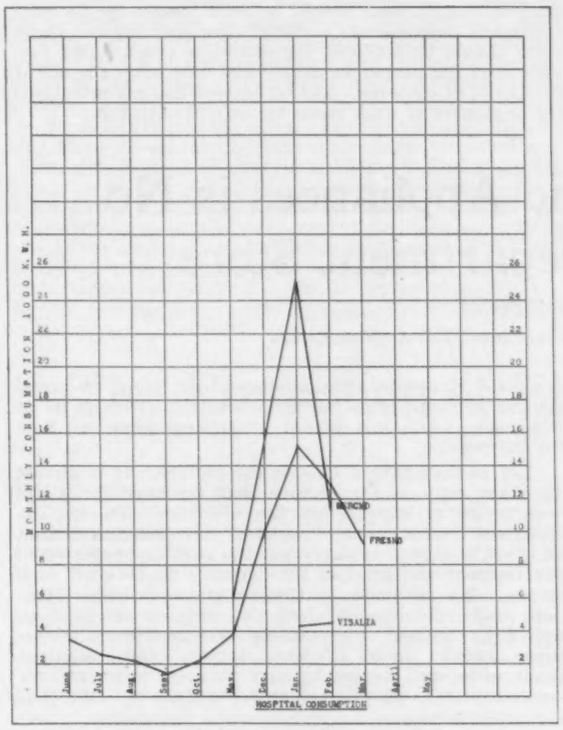

Fig. 10.—Curve showing hospital consumption by months.

Business Consumption

Sacramento—Sacramento Northern R. R. general offices.
Water Heaters, 3 kw.
Air Heaters, 62 kw.

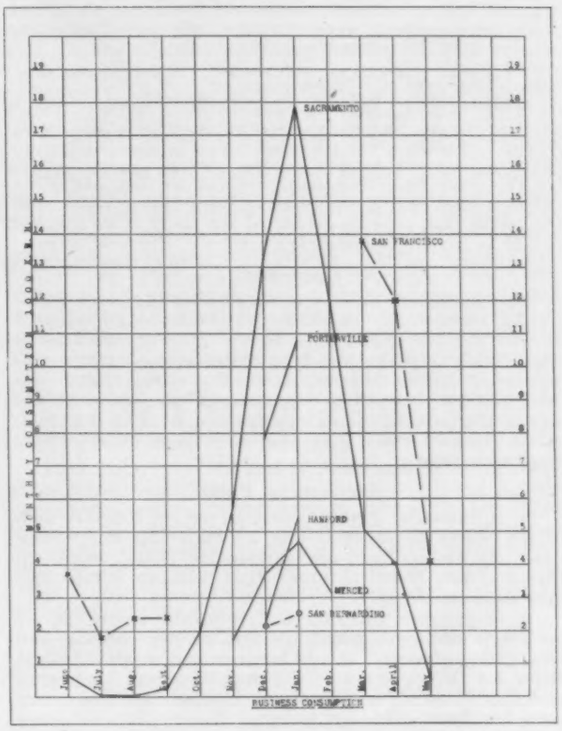

Fig. 11.—Curve showing business consumption by months.

San Francisco—Chester N. Weaver Co.
Concrete Building, 400,000 cu. ft. heated.
Air Heaters, 190 kw.

Merced—Real Estate Office.
23 ft. x 60 ft. x 16 ft.
Air Heaters, 19 kw.

Hanford—Office Building.
Two Story, 75 ft. x 200 ft. brick building.
Air Heaters, 33 kw.

Porterville—Home Bank.
Air Heaters 35 kw. (approx.)

San Bernardino—Southern Sierras Power Company Office.
Brick Building, 27 ft. x 49 ft. x 14 ft.
Air Heaters 15.86 kw.

Glossary

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Increasing the Use of Electricity for Cooking and Heating—F. H. Woodward—Journal of Electricity, May 15, 1922.

The Electric Range, Water and Air Heaters—F. C. Platt—Journal of Electricity, June 1, 1921.

Investigation of Electric Service for Air Heating in Idaho—Report of the Idaho State Utilities Commission, 1918.

The Proper Handling of Salvage, Waste and Obsolete Material

By W. J. McCULLOUGH*

THE intelligent handling of scrap and obsolete materials and equipment is one of the important features entering into material control and in a great many of our public utilities the surface has hardly been scratched when considering the savings that may be effected. We can not too clearly bring to attention the principle that nothing is to be wasted and that it is the duty of the stores department to see that everything possible is made available for further immediate service, with as few handlings as possible.

A little study shows that scrap is accumulated largely as a result of obsolescence, some breakage; also the

*Salvage, Waste and Obsolete Materials Bureau: George C. Robb, chairman; W. J. McCullough, S. B. Patterson.

wearing out of certain parts cause the accumulation of some scrap metals. However, it is from the following sources that the greater quantity is accumulated:

1.—Change of standards.
2.—Duplicate shipments of special material.
3.—Overshipments.
4.—Wrong shipments owing to wrong descriptions, etc., being given on the orders.

This material is usually retained at the suggestion of some one that it will come in handy some time, with the result that nine times out of ten there is no demand and it is carried indefinitely.

Disposition

The suggested method of disposal is that such items should, immediately on receipt at the store, be reported by the section storekeeper to the storekeeper who in turn should report same to a material committee, consisting of representatives from the engineering, construction and operating departments, who meet at the call of the general storekeeper, who should be chairman of the committee and give final disposition on any items thus accumulated.

Reclamation Plant

A reclamation plant should be under the direction of the stores department and all materials and equipment on which there are serviceable parts should go through this plant in order that nothing serviceable may be disposed of.

A thoroughly accurate and complete record of all materials and equipment, giving proper catalog and blue print reference, should be arranged in alphabetical order for the guidance of the men handling the papers and the materials at the stores in order that when an item has been officially declared obsolete it will not again be taken into stock as serviceable but will be transferred direct to the scrap and obsolete warehouse.

Classification of Materials

For convenience in handling and accounting a classification of the scrap accumulated should be set up. Following is a suggested arrangement:

Aluminum—Cable and miscellaneous
Aluminum—Cast
Brass—Borings
Brass—Castings—light and heavy
Copper—Bare
Copper—Borings
Copper—Insulated
Copper—Heavy bar and casting
Iron—Gray—cast
Iron—Malleable—cast (insulator tops only)
Iron—Wrought (includes iron rail and pipe under 3 ft.)
Lamps—Butts
Lamps—Burned out and defective—75 Watt and up
Lamps—Burned out and defective—15 to 60 Watt
Lead—
Lead—Battery Plates
Pipe—Three feet and over
Rope—
Rubber—Gloves
Rubber—Inner tubes
Rubber—Outer casings
Rubber—Boots, solid tires and miscellaneous
Sediment—Battery—mud
Steel—Angle iron, channel and "I" beams
Tubes—Boiler
Wire—Iron and cable—bare
Wire—Insulated
Zinc—

Method of Handling

It is necessary that advantage should be taken of every means to reduce the cost of handling. Labor charges should be watched continuously, giving the same consideration to the installation of labor saving machines as any good business man would do. Arrangements can be made in district stores and shops to have the scrap classified largely when it is loaded making it unnecessary to do more than unload direct to bins at the headquarters. By using care and good business intelligence in handling scrap it should be possible to do the work with a minimum of expense and a maximum of profit to the company.

Method of Pricing

The classification may be priced and sent out to various stores and departments periodically, advising them of the prices to be allowed for each item for the ensuing three months, (for example) at which time the prices may be revised by taking the total amount of each item sold during the time elapsed since the date of the last revision, dividing the quantity into the money, and, if advisable, changing the price to be allowed for the coming period. The prices shown would be for use of stores or departments transferring materials and has no connection with the price at which the sale of these materials may be made to dealers.

Sale of Salvage

A final inspection of scrap metals and obsolete machinery and equipment should be made at the time this material is loaded for sale. In order to save transportation and handling costs, scrap poles, cross arms, packing boxes, etc., should be sold locally by the districts and departments accumulating such scrap. These sales should be made on regular sales order forms furnished by the proper authority and only after the officer in charge of materials and equipment has given authority to dispose of such items by sale to outsiders.

The Selling of Electric Appliances is No Problem to the Department Store

By E. A. NORTON*

Manager, Electrical Department, Barker Bros., Los Angeles, Calif.

THE reason that the merchandising of electric appliances presents no new problem to the department store is clearly evident to most of us when we once realize that the department store simply classifies the electric appliance as an item to be bought and sold like any other item. The electric appliance is given the same treatment as crockery or clothes or toys and the same results are expected. On being assured that the margin is sufficient to cover overhead and leave a small net profit, the merchandising of the device ceases to be a problem.

The amount of business done on these devices is as much or as little as policy dictates. This rests entirely with the desire of the department manager and of course is governed by his knowledge of and interest in the devices. Sometimes the electrical devices are in a department by themselves, or in a sub-department, but more often they are simply a few of many items in a large department. The amount of electrical appliances distributed by the department stores is tremendous when compared to that sold by the strictly electrical dealers. Many department stores sell more electrical devices at retail than the large electrical jobbers do at wholesale. And this is not surprising when we look for the reason.

Let us then take a look at the picture. It is almost an exact copy of the picture that we have for years been trying to impress on the electrical dealer. The electrical dealer cannot "register" for the reason that he is not equipped to carry out the various processes of development and produce the negative that we all wish to see. We all know that when given desirable location, proper display, sufficient and complete stocks, multiplied by trained salesmanship and consistent advertising, backed up by efficient service and sufficient funds, aided and abetted by easy payment terms and attractive prices, we will get only one answer,—and that is, volume sales.

And the department store has all of these. The store is located convenient to the mass of the buying public. Careful consideration is given to the proper side of the street; proximity to street cars, and to other stores that cater to the masses; maximum amount of show window space available, and numerous other im-

*This paper is made a part of the report of the Appliance Sales Committee.

portant features. The whole thought on location is governed by the number of people of a buying mood that can be counted on to be coaxed through the doors.

The merchandise is displayed in an attractive manner in its proper surroundings. In dustless show cases or on clean shelves it presents an appeal for purchase. Experienced display men arrange and rearrange displays and sometimes whole departments in order to get the correct setting. Attractive cards get the attention of the passer-by. Dust litter and dirt are removed as soon as they are noticed by the employees. To be out of or not to carry in stock an article that is in popular demand is a reflection on the ability of the department buyer. Many stores maintain a perpetual inventory and stock clerks are on the alert to see that low stocks are immediately replenished. Department buyers have learned the lesson that to be continually out of various items causes the buying public to patronize stores that are equipped to supply their every need.

One might get the erroneous impression that the salesmen in the department stores are unfamiliar with the fine art of salesmanship. This is not the case because the heads of departments are constantly training and instructing those under them. Regular sales meetings are held. Advancement and increased compensation is available to those who show real ability. Many of the departments pay their sales people on a basis of drawing account against commissions so the incentive for volume of sales is always before them. The experienced sales person makes a very good salary because he has a vast number of customers to work on. Special commissions and bonuses stimulate to greater effort. While some of the department store sales people might lack a complete technical knowledge of the item they are selling, they do not lack a knowledge of the motives that cause people to buy, nor are they unfamiliar in the art of selling something in addition to that which the customer came in to purchase.

The effectiveness of department store advertising is evident to anyone who has seen the crowds of women rushing into a store in response to a newspaper mention of a sale or special demonstration. A woman reads the department store advertisements before she does the news or daily scandal. The advertisement departments are maintained at the highest point of efficiency. No expense is spared in this department. Talent of the highest calibre is employed. This includes copy writers, artists, photographers and so forth. It might well be said that the advertising department is the life blood of the store. Without its help the store would perish.

When one views the entire scope of the departments that have all service matters under their direction and control, he ceases to marvel at the wonderful service given by department stores. An order is placed with a sales person for an article and delivery is promised the next day, and on the next day it is delivered. If it should for any reason whatsoever not arrive on the day promised it becomes a serious organizational matter. If the article when received is not as represented or is defective the purchase price is cheerfully refunded or a perfect article is immediately delivered. Should the article not give the wear or service that is expected, satisfactory adjustment is made. An efficient adjustment department is maintained to see that the customer is made happy in the settlement of every complaint. Every effort is made to keep the good will of the customer. Good will costs a lot of money to get and is carefully guarded after being once attained. Let a customer complain to the adjustment department that her washing machine complaint has not been taken care of and someone must shoulder the blame for negligence.

Having sufficient funds the buyers can buy in large quantities, obtaining the lowest prices. Savings in freight are effected by shipping consolidated carloads. Money is always available in order to take care of special job-lots, close-outs or bankrupt stocks. Doing such a huge volume of business the department store can afford to pay salaries that are attractive enough to enable them to employ the highest type of business men. With the means of bringing to them the best men of the country it is not surprising that they have made such wonderful success.

Most of the stores find it unnecessary to liquidate their installment paper. They, therefore, are in a position to offer very convenient credit terms with low rates of interest. Having, one might say, almost unlimited funds, full advantage is taken of the opportunity to increase sales by selling on the easy payment plan. Usually a very small down payment is used to lure the customer into the store.

The department store will maintain prices on items on which there is a standard price. However, they are constantly on the alert to purchase items that are competitive to the nationally advertised brands and on which there is no set price in order that they may be used as "leaders." These items are offered at sale prices. Many times goods are sold at cost in order to get the buying public into the store. On other lines these stores buy direct from the manufacturer and the wide margin permits selling at a discount and with still a fair net profit. The department store is ever ready to take up the sale of any article that can be sold at a profit. If certain electrical devices are not sold, it may be taken as assurance they cannot be sold at a profit. Any time the electrical industry wants to make the electric range as popular as the gas stove, all that is necessary is to let the department stores merchandise them as they do other electrical devices.

In conclusion, it should be said that department stores are successful because they know how to merchandise. The knowledge of how to buy and sell at a profit has been acquired after years of hard experience. Therefore, let us not be too hard on the electrical dealer if he fails to measure up to what is expected of him. As he becomes proficient in the use of all of the tools of the merchandising trade, he will prosper and be successful. Where the industry has erred is that those who have tried to help him use these tools have not, themselves, mastered their use. One might say it has almost been a case of the blind leading the blind.

The Promotion of Electric Appliance Sales

By H. C. GOLDRICK*

THE purpose of this committee has been to study the development of electrical appliances, recommend methods to popularize their use and present plans for productive selling. (Appliances included in this work of not more than 660 watt consumption.)

To have thoroughly and consistently followed the procedure as designated by the purpose of the committee would have required many meetings and discussions but the pioneering and following of these same problems had already been conducted by the national and sectional bodies and by many of their merchandising committees. The difficulties encountered in the early days are still present, but due to the thought and action which has been expended upon them during the past few years, the mountains are not as high or the chasms as deep. A comparison need only be made between pre-war and present conditions to show how much progress has indeed been made. However, new angles on old problems have developed and it has been the endeavor of the Appliance Committee to cover these later developments.

The inroad made by the department store upon a field originally developed and exploited almost exclusively by the central station and electrical dealer has been of deep concern to all engaged in the various branches. The committee feels fortunate to be able to present herewith a paper by E. A. Norton, for seventeen years in the electrical jobbing field, and now a department head of one of the largest and most successful department stores of the entire country. His statements of facts can be profitably absorbed by the industry. It is the thought of the committee that when these

*Sub-Committee on Appliance Sales: H. C. Goldrick, chairman; J. C. Hobrecht, J. A. McWilliams, H. L. Miller, R. E. Heerman, G. W. Barker, A. L. Spring, W. C. Wurfel, C. Clifford, Carl Heilborn, A. H. Nicoll, J. P. Bowden, Fred Lantz, George T. Bigelow.

cardinal points of successful merchandising are generally adopted and practiced by all engaged in electrical selling that the major part of our problems will be behind us.

During the Fresno and Del Monte meetings certain discussions were held and some resolutions were passed, covering fundamentals of importance. In the majority of cases these have been previously included in national and sectional activities but the committee considers them of such importance as to justify a repetition with certain recommendations to meet the present day situation.

Distribution

The first electrical appliances were marketed through electrical channels exclusively; gradually other outlets have developed, in spite of an effort at one time to confine the selling within original bounds. Fortunately, the industry has conformed itself to the natural development. In order to clear any remaining doubts, the committee at the Fresno meeting went on record as recognizing the necessity of encouraging all legitimate and ethical outlets of electrical merchandising. It is the belief that there are several channels of distribution, that these will not conflict but, on the other hand, will tend to develop each other, and that local conditions will largely determine which will predominate in their respective localities. Restriction should be supplanted by cooperation. The committee has also recorded its appreciation of the pioneer work performed by the electrical contractor-dealer and has expressed its confidence in him, with a pledge to support him in his future development as an electrical merchandiser.

Whether or not a dealer may prosper on electrical sales only has been found to depend upon the dealer and local environment. There is record of many successful exclusive electrical dealers, while on the other hand, some have never prospered until they included other classes of merchandise. The successful exclusive dealer, as a rule, depends upon canvassing. The successful dealer with other lines depends largely upon stores sales. The latter appears to have been gradually brought into this arrangement due to difficulty in securing the proper type of canvasser. For those dealers who have determined upon the advisability of including other than electrical items, the committee calls their attention to the very complete report and recommendation of the Merchandise Sales Division of Electrical Merchandise presented to the N. E. L. A. at Pasadena, May 18-22, 1920. It is suggested, furthermore, that the dealer of limited capacity carefully consider the additional capital required when any expansion is planned.

Advertising

From a survey of advertising leaflets, folders and books on the stock shelf of any dealer it is quite evident that more is being produced and supplied than good judgment can justify. Hundreds of thousands of dollars are being wasted annually through neglect and obsolescence. One dealer who purchased goods to the amount of $3,000 in one year requested folders for the first part of the next year to the amount of $400. This was also in addition to an advertising allowance in the previous year of $150. The committee recognizes the value of proper advertising matter in sufficient amount to bring the article to the attention of the prospective purchaser, but it is inevitable that an unjust burden on the manufacturer must sooner or later be passed to the retail purchaser. It is recommended that careful consideration be given by the manufacturer to the advisability of making a nominal charge for all advertising matter so as to insure its economical distribution.

The value of newspaper advertising is above debate. However, some dealers are too economical while others swing to the opposite extreme and spend beyond reason. It is recommended that an annual budget be established, based upon 5 per cent of estimated sales, this to be used for consistent advertising throughout the year, and supplemented by whatever additional amounts are supplied by the manufacturer or distributor. As these two latter organizations are experienced in advertising and maintain departments for this purpose, it will be economy for the dealer to have his advertising laid out by their experts. Special campaigns or "splash" advertising should not be indulged in except after due deliberation and consultation with the manufacturer or distributor and then only when the expense can be positively justified.

Salesmen

The lack of retail salesmen is felt today by every dealer in electrical merchandise, but more especially by the dealer who depends to any extent upon canvassing. After lengthy consideration of this situation at the Del Monte meeting the following resolution was unanimously adopted:

WHEREAS it has developed in discussion that education on electric sales and application is still very much needed among the ranks of the industry, especially among those who meet the public in any capacity whatsoever, namely: salesmen, wiremen, metermen, troublemen, servicemen, deliverymen, minor executives, etc. and

WHEREAS there is a manifest lack of consideration on the part of these people as to the service which these devices will render, together with a lack of knowledge of the device itself and its application, be it therefore

RESOLVED that a means should be provided by one of the national co-operative organizations—either the N. E. L. A. or the S. E. D.—which means should present to all members of the industry the comfort and usefulness which electrical appliances render in daily life and the savings effected by these devices, and be it further

RESOLVED that this means be made available through all the various electrical organizations to all members of the electrical industry, these organizations being the A. F. of L., I. B. E. W., and all other organized bodies interested in the electrical development of the United States.

The spirit of this resolution is in accordance with the work which has already been done by the national body in formulating and offering at cost a course of instruction to electrical salesmen. An announcement of a new course for $12 was made in the February number of the N. E. L. A. Bulletin. The committee at the Del Monte meeting recommended that a delegate be sent to the national meeting to lay special emphasis upon more intensive sales training of the present employees in electrical selling organizations and offering inducements to attract more and desirable talent into electrical selling. All manufacturing and distributing organizations now have sales promotion departments equipped to train the dealers' organizations toward better selling and the committee earnestly urges that every selling organization call upon its suppliers for this help, which is to be had for the asking.

Profits

The margin of profit to the dealer from sales has been gradually increasing until there is now a fair balance left for net. The increase has in most cases resulted from higher re-sale prices, thus passing it to the retail purchaser. It is apparent that the limit in this direction has been reached and in order to allow additional margins to the dealer which will put him on the same level with merchants of other lines, it will be necessary to effect savings in production and distribution costs. The former is in the hands of the manufacturer entirely and without question is receiving proper attention. The latter is in the hands of the dealer as well as the manufacturer or distributor. The dealer can assist in lowering costs of distribution by properly anticipating his requirements:—thus saving rush shipments,—ordering in standard package lots, and in minimum weight quantities. Unjust requests upon the supplier for replacements, free service on appliances when due to the customer's fault, and unwarranted sales assistance or duplication of effort, all lead to increased costs. The application of the golden rule will eventually react in lower costs and lower prices to the public. As costs are lowered it will be possible to increase remuneration to the sales organization and thus attract the type of personnel which we wish to make a part of the electrical industry, in one branch or another.

Conclusion

A review of conditions in the field and a digest of the various topics discussed at the Fresno and Del Monte meetings, as well as in sub-committee meetings, demonstrate that the entire industry is alive to the problems facing it, that genuine effort is being made to solve these problems and that actual progress is being made. There are more successful merchants of electrical appliances than ever before and the volume of sales is increasing at a healthy rate.

To continue, the industry must continue to act as a unit, the new problems must be frankly discussed and acted upon in one accord, and strict economy in time and expenditures must be practiced. The year 1924 promises to be one of the best appliance years.

The Electric Truck—The "Super-Appliance"

By J. S. MOULTON and A. B. WOLLABER*

THAT the electric truck is rapidly coming into its own can no longer be disputed. Probably the greatest mistake was its too early birth. Years ago when all trucks were new and undeveloped, the electric made its appearance amid great applause. Poor roads, ill adapted work, inefficient motor and chassis design, added to frail battery construction, all but killed it. Then came the gas truck. Unlimited mileage and speed were topmost in the minds of transportation executives. Helped by the popularity of the gas motor car, the intricacies of gas engines, maintenance and repairs were minimized. Due to immense production, cost prices were declining even as value and efficiency were decreasing. A perspective view could hardly discern the electric snowed under.

However, there were a few far seeing manufacturers who knew that fundamentally the electric was right. Given the same engineering development, the electric would demonstrate its particular superiority for certain types of transportation. They plugged along. Electric motors and batteries were products of unlimited application and made by manufacturers of international reputation. Inprovements on these items were as rapid as the use of electricity. Chassis designs were adapted from the latest gas truck practice. From the very inception of the electric truck there were many large organizations which recognized its merit and continued to use and purchase more for specialized work. Among these is the American Railway Express Company—a company that depends on economical transportation as its sole source of revenue—which today operates about 1,800 electric trucks.

With the cooperation of motor manufacturers, battery manufacturers and power companies, electric vehicle manufacturers have today produced storage battery propelled trucks which are unrivaled on the ground of economy, by any other mode of transportation. The electric, even with its relatively low speed and limited mileage, has a definite field in which it excels. As prejudice gives way to open minded investigation, as competition forces greater economy, and as corporation executives introduce cost accounting records in their methods of selecting delivery equipment, the faster will be the championing of the storage battery propelled vehicle.

At the present time the small margin of profit which exists in many industries together with the demand and necessity of reducing operating costs and thereby reducing the price differential which exists between raw materials and manufactured products delivered to the consumer, is forcing all kinds of business enterprises to take advantage of the economies in city transportation offered by the electric truck.

The increased interest displayed in keeping record of delivery costs, together with the more congested traffic and better pavements of the western cities is focusing attention on the electric street truck. Detailed investigation has shown that the cost of delivery of products which are distributed from house to house or from store to store within the cities of this country ranges from 11 per cent of the selling price for dairy products to as high as 50 per cent for ice. Realization of the large portion of the total sales price which goes for delivery must direct attention to the increased profit which can be realized through cutting this delivery cost. As it is not unusual for electric trucks to effect a saving of 40 to 50 per cent in delivery costs when used to replace horse drawn vehicles or gas trucks, the reason for the increased interest and use of the electric becomes evident.

The Field of Use on the Pacific Coast

The use of electric trucks, particularly on the Pacific Coast, is in its infancy and the field cannot by any possible stretch of the imagination be considered saturated. The sale of each and every electric truck at the present time makes just that much easier the sale of the next truck. It is indeed fortunate that the dealers handling the various makes of electric trucks together with the battery manufacturers and a number of the power companies realize this situation and are working hand in hand toward a common goal. It has been the experience in the past that this cooperation has resulted in more and better business for everyone concerned and it is the sincere hope of the transportation bureau that such cooperation will continue and be strengthened as time goes on.

Desirability of Power Battery Load

Several of the Pacific Coast power companies have been apathetic in their interest in electric trucks, possibly neither realizing the very desirable characteristics which the electric truck battery charging load has nor appreciating the large revenue which might be built up by an active campaign to place electric trucks in their territory. The eastern power companies as a group actively foster the use of electrics and have thereby built up a very lucrative source of revenue without increasing their plant investment to any extent. The charging of the battery is done during the night when the load on the power system is below average, which means that practically no additional investment is necessary for generating equipment, transmission lines, substations or distribution lines, as electric truck garages are usually located where they can be served from existing distribution facilities.

In attempting to increase the use of electrical appliances which the power companies are convinced bring them a desirable revenue, the companies have found that they should encourage their employees, or should use themselves wherever possible, the self-same appliances. It is an accepted fact that the electric truck charging load is a desirable one and it seems difficult to understand why certain of the utilities are not using electric trucks in their operations and encouraging the use of trucks within their territory. The transportation bureau is lending its efforts in an attempt to enthuse all of the Pacific Coast companies with the desirability of making active sales efforts for the placing of electric trucks and tractors wherever they are suited to the work at hand.

Necessity for Keeping Cost Data

The lack of cost data in the past has been one of the hindrances to the wider use of the electric truck as without such information it is, of course, impossible to tell whether or not electrics are operating cheaper than horse drawn vehicles or gasoline trucks. More and more concerns are starting to keep accurate costs, however, and at least one concern on the Pacific Coast is engaged in keeping cost records at a very nominal monthly charge for subscribers who do not wish to do their own bookkeeping. This bureau can not too heartily endorse any move which will tend to increase the accurate keeping of truck operating costs as these cost records will do more than any other thing in promoting and encouraging the use of electric trucks.

"Electrics" Are Sold as Economical Transportation

Electric trucks with the various sizes and types of batteries which may be used in them comprise a very efficient unit of transportation when correctly chosen for the intended work. The electric truck should not be sold from a catalog without any investigation of the use to which it will be put, but should actually be fitted for the work at hand. The dealers handling electric trucks and batteries on the Pacific Coast sell economical transportation rather than electric trucks. It is the hope of the bureau that this will continue to be the case and that as more and more individuals become interested in this field, the growing use of the electrics will not tempt a misapplication simply for the possibility of making a sale.

Because of the fact that electric trucks are sold for particular purposes, cost figures on the operation of these trucks must be considered purely in the light of the work they are doing and compared to the cost of

*Committee on Commercial Truck Operation: J. S. Moulton, chairman; S. B. Shaw, J. Jerome Canavan, K. I. Dazey, E. A. Hunt, Harry D. Easterbrook, Frank Rettenmeyer, P. H. Ducker, H. Y. Stebbins, D. B. Rose. Committee on Batteries: A. B. Wollaber, chairman; C. L. McWhorter, L. F. Boerner, G. F. Wakeman, O. W. Lillard, Eddy Wood.

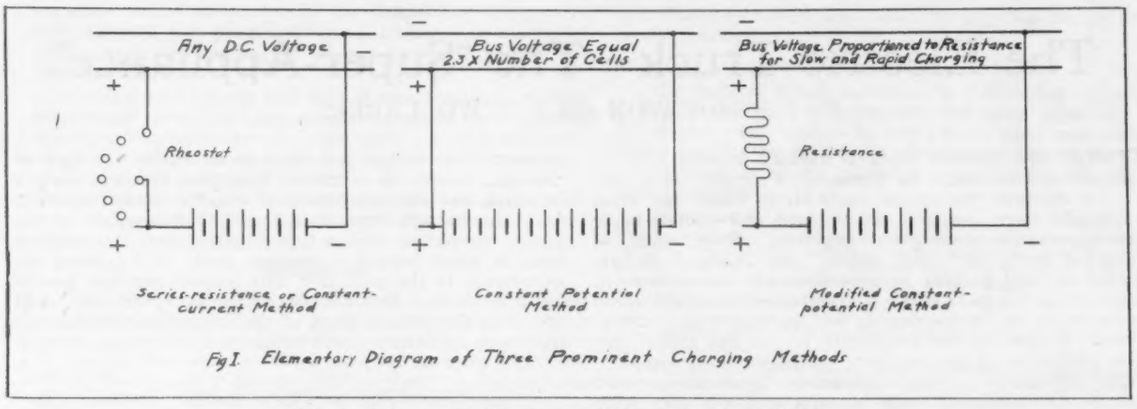
Any D.C. Voltage
Rheostat
Bus Voltage Equal 2.3 X Number of Cells
Bus Voltage Proportioned to Resistance for Slow and Rapid Charging
Resistance
Series-resistance or Constant-current Method
Constant Potential Method
Modified Constant-potential Method
Fig I. Elementary Diagram of Three Prominent Charging Methods

Fig. 1.—Diagram showing three methods of charging batteries.

gasoline or horse drawn vehicles performing the same work, and not compared at random with costs of vehicles doing other work under different conditions. The truck dealers are transportation engineers. Any concern having city deliveries should be interested in electric trucks. It will be to their advantage to call on a truck dealer and ask him for a report on the practicability and economy of applying electric trucks to this use.

Truck transportation is a highly specialized industry meriting the analysis of an expert where large fleets are involved. For long interurban and high speed hauls the gas truck is undisputed leader. But there is a broad field of city transportation which is characterized by moderate mileage, many stops and relatively low speed necessitated by traffic congestion which can most economically be filled by the electric truck.

Batteries in Electric Trucks

As the life and proper operation of the electric vehicle is largely dependent upon the battery, this committee has been very careful in its investigations to be guided only by what could be considered the best practice with this very important subject. It was found to be quite impossible to confine its investigations or this report to any particular make of battery because

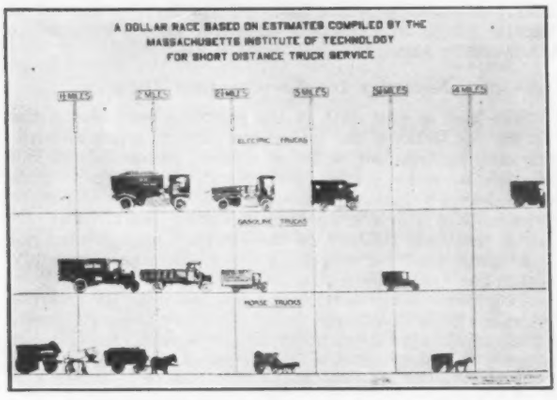
A DOLLAR RACE BASED ON ESTIMATES COMPILED BY THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY FOR SHORT DISTANCE TRUCK SERVICE
ELECTRIC TRUCKS
GASOLINE TRUCKS
HORSE TRUCKS

Fig. 2.—Showing distance traveled by electric truck, gasoline truck, and horse truck per dollar.

it is obvious that an injustice might be done to certain makes of batteries if due care was not taken in considering the conditions under which they were to be operated. Certain batteries are adapted to certain classes of work and one battery might well be considered a success in one line of work while if put to another test might prove to be more or less unsatisfactory. It seemed, therefore, that it would be best to approach the subject from an impartial standpoint leaving out of consideration any particular make of battery.

A great deal has already been published on the subject of batteries as affecting Eastern operation of electric vehicles, but here in the West there is an utter lack of authentic information upon which to base a report, either as regards cost of operation or maintenance. It is a fact that the majority of users of the electric vehicle in Western territory appear to be too well satisfied with its operation to give very much consideration to the preparation and keeping of cost data. As a matter of fact we could find but few users of electric trucks in this territory who keep details of cost on maintenance of trucks or batteries sufficiently accurate to serve any useful purpose at all.

Cost of Operation

Until such a time as the industry is in a position here on the Pacific Coast to obtain accurate cost data in connection with the use and operation of electric vehicles, particularly as pertains to the battery, it is thought best to consider a hypothetical case of battery cost which can easily and fairly be estimated, rather than to take the meagre data available in this connection. For example, assuming a battery for a one ton electric which costs about $1,000 and has an average life of four years; interest at 6 per cent on the investment and power at three cents per kw.-hr., allowing for 300 working days per year and wastage of current:

Cost	$1,000
Interest at 6%	240
Power for charging	600
Four year total	$1,840

Or $460 per year which is $38.33 per month per battery.

Care and Maintenance

So far as maintenance is concerned there are just four rules on batteries:

1. Charge properly
2. Flush regularly
3. Do not overheat or overwork
4. Keep dry and clean

The first item is the most important and it is the easiest to comply with if proper charging equipment is installed. A representative of the battery manufacturer should be asked to specify the type and details of equipment to be used for each power situation. If proper size and type of battery is installed in the truck by the selling agent the third item is taken care of. Cleanliness is important and easily complied with if, like flushing, it is put on a routine basis.

Charging Systems

Battery charging in the early days of electric vehicles was a very different proposition from the present day methods. Proper charging equipment today is automatic, requires no manual adjustments and absolutely protects the battery from overcharging and overheating. Direct current alone can be used for charging. If alternating current power only is available, it must be converted into direct current. This can be done by means of— (a) Synchronous converter, (b) Motor generator, and (c) Mercury arc rectifier.

There are now three methods of charging in general use. These are listed below in the order in which they came into use. (See Fig. 1.)

1. The series-resistance or constant-current method is the original charging system. It is used where an attendant is available or where the other methods might be impractical due to a great variety of battery voltages or other reasons.

2. The constant-potential method was adopted many years ago and is used with considerable success in that it requires about 15 per cent less time in charging than the other methods. Any slight variations in bus voltage cause great variations in charging rate which may be harmful to the battery.

3. The modified constant-potential method is really a combination of the two foregoing methods and is very rapidly gaining in popularity. The only difference in connections is the addition of a fixed resistance. This resistance acts as a cushion to take care of "shocks." There is little doubt but that this system is the system of the immediate future.

In order to determine what kind and capacity of charging apparatus is necessary, the following information must be obtained:

1. Time available for charging
2. Number of cells and capacity in ampere-hours
3. Number of batteries to be charged at one time

Regardless of the method of charging used or the kind of battery charged, an automatic device for disconnecting the battery when the charge has been completed is essential and is standard equipment on all modern electric trucks. This device is merely a combination ampere-hour meter and electro-magnetic trip for opening the charging circuit. The average storage battery of good construction can usually be given a full charge in a period of approximately nine hours without deterioration or injury to the battery itself. Obviously, charging should be done without the necessity for excessively gassing the battery or overheating it, and of course the level of electrolyte or solution in each cell should cover the plates and separators in that cell.

As to the efficiency of the electric battery, the conversion of electricity from the battery into power at the wheels is dependent upon the efficiency of the electric motor, the wiring and the transmission of the vehicle. The transmission is no less efficient than that in a gas car, and it is believed the electric motor (75 per cent efficient) is considered to be as efficient or more so than the most efficient internal combustion engine (20 to 25 per cent efficient) applicable to automotive use. Certainly when we consider that the electricity is used only when the vehicle is operating and is never allowed to run or be used when the vehicle is standing, as it is with most gasoline trucks, obviously less actual energy is wasted with the electric.

Quoting from the Electric Truck Bulletin edited by the National Electric Light Association:

"Many a hostler and stable man is today handling batteries with all of the ease and none of the worry with which he cared for and fed horses. He had rules for feeding and caring for horses. He has no more and less exacting rules for handling his batteries."

That the storage battery requires far less maintenance and attention than the gas engine is so self-evident that further discussion is hardly warranted.

The appendix to this report contains a number of cost figures obtained from the Pacific Coast concerns operating electric trucks. These figures speak very forcibly for the economy of the electric. A more graphic idea can be obtained of the economy of the electric by means of the letters which also follow this report from various concerns using them.

The bureau can report a large increase in the interest displayed in electric trucks and very bright prospects for a considerable growth in their use during 1924.

APPENDIX

COST OF SIX ONE-TON ELECTRICS IN DEPARTMENT STORE USE, LOS ANGELES, CALIF.

Car Number	1	2	3	4	5	6
Charging Costs	$ 12.35	$ 20.00	$ 17.00	$ 18.50	$ 13.30	$ 12.00
Repair Parts	2.00	3.60	.50	1.35	3.60	3.15
Repair Labor	8.30	11.10	6.90	8.00	14.00	9.80
Tires	7.00	6.60	6.00	6.85	11.50	9.10
Body Repairs	15.00	15.00	15.00	15.00	15.00	15.00
Garage Overhead	48.00	48.00	48.00	48.00	56.00	57.50
Insurance	7.00	7.00	7.00	7.00	7.00	7.00
Depreciation	76.00	79.00	75.00	88.00	76.00	73.50
Total	$175.65	$190.30	$175.40	$192.70	$196.40	$187.05
Miles per Month	490	993	800	830	650	860
Cost per Mile	.358	.192	.219	.232	.302	.218

Costs are average for one month covering six months' period.
Depreciation figures on 20% a year, which is high for electric trucks.
Garage overhead is also high, due to expensive property used.

COST OF OPERATING AND MAINTAINING ONE TWO-TON ELECTRIC TRUCK UNDER NORMAL OPERATION OVER CITY ROUTES IN SAN FRANCISCO

Investment		
Electric Truck	$2,984.25	
Battery	1,218.90	
Total Investment		$4,203.15

Fixed Charge (Chassis Less Tires)	Cost per Year
Interest at 6% on Total Decreasing Investment over Period 10 Years, Average 3.2%	$88.46
Depreciation at 10% per annum	276.43
TOTAL FIXED CHARGES PER YEAR	$364.89

Operating Costs	Per Year (12,000 Mi.)	Per Mile
Battery Renewal Sinking Fund—4 Yr. Avg. Life	$314.10	.026175
Tire Renewal Sinking Fund—Adjust. on 10,000 mi.	268.00	.022333
Mechanical Repairs Sinking Fund	120.00	.010000
Current at 1.2c per kw-hr. 12,720 kw-hr. (1.06 kw-hr. per mile)	152.64	.012720
Grease	6.00	.000500
TOTAL OPERATING COSTS	$860.74	.071728

YEARLY COSTS FOR DIFFERENT MILEAGES

Avg. Miles per Day—300 Days per Year	Avg. Miles per Year	Total Fixed Charges	Operating Cost per Mile	Total Cost per Year	Total Cost per Day	Total Cost per Mile
25	7,500	$364.89	.071728	$ 902.85	$3.01	.12038
30	9,000	364.89	.071728	1,010.44	3.37	.11227
35	10,500	364.89	.071728	1,118.03	3.73	.10648
40	12,000	364.89	.071728	1,225.63	4.08	.10213
45	13,500	364.89	.071728	1,333.22	4.44	.09876

Route No.	Miles	No. of Stops	Time	2-Ton Truck Kwh.	Cost at 1.2c Mile
1	22.3	50	2 hrs.	21.25	.255
2	19.7	50	1 hr. 51 min.	22.30	.268
3	9.9	15	45 min.	8.50	.102
4	9.8	30	50 min.	9.60	.115
5	13.5	12	1 hr. 10 min.	14.00	.168
6	7.8	35	1 hr. 10 min.	10.60	.127
TOTAL	81.0	192	7 hrs. 46 min.	86.25	$1.035

(NOTE.—Name of User will be Furnished upon Request.)

OPERATING AND MAINTENANCE COSTS OF 3 ELECTRIC TRUCKS ON SHIPPING AND DELIVERY WORK UNDER SAN FRANCISCO CONDITIONS

	Miles
No. 1 1-Ton Electric Delivery Wagon in service 46 months	26,528
No. 2 2-Ton Electric Delivery Truck in service 39 months	18,910
No. 3 3½-Ton Electric Shipping Truck in service 46 months	17,140

DAILY AVERAGES MONTH OF DECEMBER

	1-Ton Month of December 26 Days	2-Ton Month of December 26 Days	3½-Ton Month of December 26 Days
Mileage	26.84	21.5	15.615
Cartage	$10.273	$ 9.627	$12.916
Current (4c per kw-hr.)	$ .805	$ .86	$ .937
Number of Marks	37.08	21.50	20.692
Weight in lb	4,441.68	8,310.115	14,796.23
Weight per Mark	119.786	386.535	715.057

EXPENSES FOR DECEMBER

Wages	$ 75.00	$ 91.15	(a)$ 104.50
Garaging	20.00	27.50	35.00
Current (4c per kw-hr.)	21.95	22.36	24.36
Repairs and Renewals	0.00	0.00	(b) 50.00
Tires	0.00	0.00	0.00
Liability Insurance	4.16	4.16	4.16
Fire Insurance	2.25	3.37	4.50
Interest on Remaining Principal	0.00	0.00	0.00
Depreciation (12%)	32.50	40.40	52.40
Total Expense for Month	155.86	188.94	274.92
Total Earnings for Month	256.83	250.30	335.84
Net Earnings for Month	100.97	61.36	60.92

TOTALS TO JANUARY 1ST

	46 Months	39 Months	46 Months
Original Total Cost of Trucks	$ 3,250.00	$ 4,040.00	$ 5,240.00
Wages	3,183.08	(a) 3,184.91	(a) 4,658.12
Garaging	920.00	1,072.50	1,610.00
Current	804.82	764.15	1,076.86
Repairs and Renewals	907.14	912.40	1,099.46
Tires	492.91	451.86	552.16
Liability Insurance	191.91	162.24	191.91
Fire Insurance	103.80	131.43	207.60
Interest	274.58	288.22	244.59
Total Expenditures	10,128.24	11,007.71	14,880.70
Total Earnings	11,318.33	11,088.47	18,511.92
(c) Surplus above all costs	1,190.09	80.76	3,631.22
Average total cost per month to date	182.03	219.06	261.98

(a) Wages include cost of helper when needed.
(b) No. 3 was painted in November.
(c) Net profit after paying for investment and operating expenses.

SAN JOAQUIN LIGHT & POWER CORPORATION
Fresno City Water Corporation
Operating Costs of Electric Trucks
To April 1, 1924

Capacity	1-Ton Electric	1-Ton Electric	2-Ton Electric	¾-Ton Electric	¾-Ton Electric	2-Ton Electric	1-Ton Electric
Date in Service	12-22-22	12-1-23	12-22-22	11-29-22	9-10-23	10-31-22	1-1-23
Repairs and Maintenance							
Battery	.56	.....	.....	.....	.....	3.60	.....
Electric Equipment	5.36	.....	31.34	10.91	.....	30.97	9.98
Chassis	74.74	35.99	25.83	153.35	6.39	36.45	22.78
Charging (Labor and Water)	100.34	8.98	111.17	51.73	49.88	117.09	103.90
Tires and Tubes	4.43	.....	.....	7.86	.....	5.37	.....
Lubrication	2.85	.....	8.63	10.24	.04	8.37	8.49
Power	111.55	44.56	234.42	132.18	34.51	236.50	202.28
Painting	.....	.....	8.65	.....	.....	.....	.....
Garage Overhead	139.46	57.27	135.54	158.50	57.27	159.33	150.12
Total	439.29	146.80	555.58	524.77	148.09	597.68	487.55
Miles operated	5,548	1,649	6,473	7,637	1,955	7,394	8,034
Cost per Mile	.079	.089	.086	.068	.076	.081	.061
Amp. hours per Mile	3.606	4.536	6.250	2.964	3.822	5.567	4.635
Chassis Depreciation	.02	.03	.03	.02	.03	.03	.02
Battery Depreciation	.025	.03	.03	.025	.03	.03	.025
Speed—loaded	15–16	13–14	14–15	15–16	14–15	12–13	11–12
Use	Electric Service Crew	Water Service Crew	Storeroom Freight	Water Service Crew	Storeroom Express	Storeroom Freight	Watermeter Sets and Seals

Power costs based on 2c per kw-hr. to motor generator set

OPERATING COST ON 3½-TON ELECTRIC TRUCKS IN ICE CREAM DELIVERY, LOS ANGELES

Truck No.	MAY Miles	MAY Kw-hr.	JUNE Miles	JUNE Kw-hr.	JULY Miles	JULY Kw-hr.	Total Miles 3 Months	Total Kw-hr. 3 Months	Cost of Power 3 Months	Avg. Cost per Month
1	646	1,116	658	1,079	652	1,226	1,956	3,371	$67.42	$22.44
2	645	1,119	665	1,178	683	1,194	1,993	3,491	69.82	23.27
3	493	912	467	776	638	1,052	1,598	2,640	52.80	17.60
4	931	1,530	866	1,497	922	1,793	2,719	4,820	96.40	32.13
5	780	1,176	700	1,096	797	1,180	2,277	3,452	69.04	23.01

No record of any repair cost.
Power figured at two cents per kw-hr.
Average days per month operated—29.

GLOBE MILLING COMPANY, LOS ANGELES
COMPARATIVE OPERATING COSTS—GAS AND ELECTRIC TRUCKS
Figures Give Average Cost per Month

	55 5-Ton Gas	61 5-Ton Gas	62 3½-Ton Electric	63 3½-Ton Electric
Truck Number				
Capacity				
Type				
Repairs and Maintenance				
Material (Repairs)	$2.20	$2.30	.....	$0.15
Labor (Repairs)	4.30	2.50	.....	.....
Battery	.....	.....	$0.60	.60
Power at 1.7c kw-hr.	.....	.....	8.45	8.30
Grease	2.00	.45	.17	.60
Oil	2.08	2.00	.....	.....
Gas	39.30	33.00	.....	.....
Washing	7.25	8.00	4.80	3.50
Garage Overhead	8.00	8.00	8.00	8.00
Total	65.13	56.25	22.02	21.15
Days Operated	25	25	25	25
Miles per Month	1,173	1,127	622	667
Stops per Month	314	476	700	813
Tons Delivered	290	263	285	294
Ton-Miles	340,000	296,000	177,000	196,000
Unit Costs				
Per Day	2.605	2.250	.881	.846
Per Mile	.055	.050	.035	.032
Per Ton-Mile	.002	.002	.001	.001

Data cover average cost per month taken over six months period. No actual tire cost was obtainable.

PACIFIC STATES ELECTRIC COMPANY
ANALYSIS OF MAINTENANCE OF DELIVERY AUTOS FOR YEAR 1922

				ANALYSIS OF EXPENSE PER MILE				ANALYSIS OF EXPENSE PER TON				
	Total Expense	Total Mileage	Total Tonnage	Gas and Oil	Storage Repairs Sundries	Tires Tire Repairs	Total	Gas and Oil	Storage Repairs Sundries	Tires Tire Repairs	Total	Age of Truck
Portland												
Electric 21 (1 ton)	$ 378.33	2,606	403	.....	.1452	.....	.1452	.....	.9388	.....	.9388	1913
Gasoline 29	802.22	9,701	553	.0283	.0382	.0162	.0827	.4966	.6704	.2837	1.4507	1921
Total	1,180.55	12,307	956	.0223	.0609	.0127	.0959	.2873	.7835	.1641	1.2349	
San Francisco												
Gasoline 30	526.72	1,669	146	.0565	.2149	.0442	.3156	.6460	2.4568	.5049	3.6077	1923
Electric 33 (2 ton)	1,214.76	3,255	1,538	.....	.3732	.....	.3732	.....	.7898	.....	.7898	1913
Electric (1 ton)	1,177.13	3,675	805	.....	.3043	.0160	.3203	.....	1.3892	.0731	1.4623	1913
Gasoline	1,156.63	10,123	498	.0349	.0582	.0212	.1143	.7087	1.1826	.4313	2.3226	1921
Total	4,075.24	18,722	2,987	.0239	.1752	.0186	.2177	.1497	1.0983	.1162	1.3642	

NOTE.—Greater mileage results in lower cost per mile. Electric truck mileage could be increased 100% to 200% with only a fractional increase in cost. This condition does not apply in same proportion to gas trucks.

Attention is called to the relative ages of the gas and electric trucks.

COMPARATIVE COSTS OF GAS AND ELECTRIC TRUCKS IN BAKERY USE, LOS ANGELES, CAL.

Figures taken over one year and given as average for one car month covering costs on 32 ¾-ton gas cars and 33 ¾-ton electrics.

	Gas	Electric
Repair Parts	$13.00	$ 0.25
Repair Labor	21.00	13.25
Oiling Labor and Oil	9.00	.....
Gasoline	18.00	.....
Power at 1.3c kw-hr.	.....	10.00
Tires	14.00	6.25
Washing and Polishing	13.50	11.20
TOTAL	$88.50	$40.95
Miles per Day	85	40
Days Operated	28	28

Depreciation 25% per year for gas trucks.
Depreciation 10% per year for electric trucks.

COST OF OPERATING TRUCKS ON GARBAGE COLLECTION FOR FISCAL YEAR 1922-23, PASADENA, CAL.

Gasoline Trucks	Gas	Oil	Repairs Inc. Tires	Total Cost per Mile
1918 Truck	.07236	.01069	.36096	.4440
1916 Truck	.08047	.00603	.07093	.1574
1917 Truck	.06950	.00541	.20899	.2839
1921 Truck	.02928	.00141	.07548	.1061
Electric Trucks		Charging	Repairs	Total
1922 Truck		.07981	.01832	.0981
1922 Truck		.09293	.06111	.1540

(Copy)

JERSEY FARM DAIRY CO.
Tuolumne & H Streets.

Fresno, Cal.,
Mar. 20, 1924.

Electric Transportation Assn.,
San Francisco, Cal.
Gentlemen: Attention: E. J. Power, Secy.

In regard to cost of operation of electric trucks, I am pleased to state that up to the present time we have had only one case of expense other than the monthly power bill. This one expense was for replacing electrolyte in the battery of our first truck after it had operated for twenty months and covered 8600 miles. The total cost of renewal of this electrolyte will be just $50.00.

The monthly power bills for the past year covering three Electrics, have averaged $39.57 or $13.19 per truck. The trucks cover between 14 and 15 miles per day and make 400 stops. They operate 30 days a month so the cost of power has been three cents per truck mile. This cost per truck mile has been at an average rate of $.0203 per kwh.

Two new Electric Trucks started work at the end of January making a total of five now in operation.

Yours very truly,
JERSEY FARM DAIRY COMPANY
(Signed) J. Sleanham,
Manager.

(Copy)

FROM THE LABORATORY
of
THOMAS A. EDISON

Orange, N. J.,
October 17, 1923.

Pacific Gas & Electric Co.,
San Francisco Division,
San Francisco, Cal.
Gentlemen: Atten. Mr. E. J. Power.

Delivery cost at this time has assumed a greater importance than ever before.

Any merchant who keeps accurate delivery costs will purchase electric trucks for city delivery in self defense. A concern us-

ing electric trucks for delivery can undersell his competitor using gas trucks and make as much profit as a man using other kinds of delivery.

Yours very truly,

(Signed) THOMAS A. EDISON

TAE:FTR

(Copy)

OLD HOMESTEAD BAKERY

19th & Howard Sts.,
San Francisco, Cal.

March 29, 1924.

Mr. E. J. Power, Director,
Electric Transportation Bureau,
Pacific Coast Electrical Assn.,
445 Sutter St.,
San Francisco, Cal.

Dear Sir:

Replying to your inquiry asking for an opinion on the economy and efficiency of electric trucks for City delivery, we beg to say that we find electric trucks to be the most satisfactory method of wholesale bread delivery. They are as economical as horse drawn vehicles and are more economical than gas cars, and in many respects more satisfactory than either of the above mentioned.

Our entire equipment for City delivery is comprised of (45) electric trucks. A few of these have been in operation for (10) years and are still rendering very excellent service. We strongly recommend electrics for City deliveries.

Yours very truly,

OLD HOMESTEAD BAKERY, INC.
By (signed) H. A. Banzhaf
Vice President.

(Copy)

GENERAL ELECTRIC COMPANY
General Office
Schenectady, N. Y.

San Francisco Office
Rialto Building
San Francisco Warehouse
361 Bryant Street

April 24, 1924.

Mr. E. J. Power, Chairman,
Transportation Bureau,
Commercial Section, P. C. E. A.,
445 Sutter Street, CITY.

Dear Sir:

Replying to your favor of March 27th will state we have been using three electric trucks for the past twelve years and have found them satisfactory in their entirety for our drayage service. During these twelve years we have had a minimum amount of trouble with a maximum service.

In the City, the electric truck is the most economical unit to operate because its costs can be accurately calculated and the element of doubt removed. This making it possible to write off all operating charges as fixed charges.

The electric truck meets our requirements of stability and speed better than any other method of transportation, at a cost of from 25% to 50% lower. It travels as rapidly as is consistent with safe driving, maintaining a high average of speed due to its quick acceleration and ease of control, while its dignified appearance and noiseless operation makes an impressive advertisement for its owner.

In closing, let me again call your attention to the long life, dependability and economy of operation of our three trucks. "The proof of the pudding is in the eating."

Very truly yours,

(signed) H. L. Nagel
MGR. S. F. WAREHOUSE

HLN:HAS

BURR CREAMERY CO., LOS ANGELES, CAL.
COMPARATIVE COSTS OF GAS AND ELECTRIC TRUCKS IN DAILY USE

Costs are Average Cost per Car per Month Covering Operation of 49 Gas and 44 Electric Trucks

	Gas	Electric
Total Labor per Month	$ 63.00	$15.60
Total Parts per Month	35.00	6.00
Oil and Gas	39.00	.....
Power Cost	.....	12.69
Depreciation	30.00	30.00
Total	$167.00	$64.29

All cars average 35 miles per day.
Depreciation figured on cost of $4,000.00 for electric and $750.00 for gas.

ALFRED ICE CO., LOS ANGELES
Costs of Electric Trucks in Ice Cream Delivery for One Year

	No. 38	No. 40
Cost of Power	$ 85.52	$ 75.53
Repairs and Distilled Water	57.43	72.83
Other Costs	7.44	7.44
Total Operating Cost	150.39	155.80
Miles per year	4,547	3,992
Gallons delivered	53,115	46,870
Cost per Mile	.033	.040
Cost per Gallon	.0028	.0033

ICE DELIVERY IN FRESNO
Costs of 2-Ton Electrics for One Year

	No. 1	No. 2
Power Cost	$ 31.90	$ 31.90
Distilled Water Cost	5.75	5.75
Garage Labor	107.18	106.74
Lubrication	.....	.17
Lighting System	.....	.73
Rear Assembly	.73	4.62
Top and Body	.....	.52
Insurance	42.03	53.83
Sundries	24.22	35.15
License	20.00	20.00
Total	$ 231.81	$ 259.41
Cost per mile	.092	.113
Driver's Pay	1,688.53	1,629.26
Cost per Ton Delivered	1.69	2.57
Miles Run	2,522	2,289

Electric Industrial Trucks and Tractors as Revenue Builders for Central Stations

By E. J. POWER*

IN practically every line of business, one of the many problems which may arise is that of inter-departmental transportation in one phase or another. Increasing costs of labor and the demand for speed in material handling, as well as lower insurance rates, better building ventilation, and cleanliness have resulted in the development of the electric industrial truck and tractor for handling material in manufacturing plants, warehouses, steamship docks and railroad freight terminals. Fundamentally it is the desire of every man in whose hands the efficient management of the business is placed, to move the material in the quickest possible time, and with the minimum amount of labor. These executives are attaining their objectives through the help of the electric industrial truck and tractor as evidenced by the thousands that are now in use. These little vehicles are proving themselves indispensable in this work to operators who need a cheaper and more efficient method of moving material as they are small enough to negotiate narrow aisleways, yet sufficiently powerful to move heavy loads easily and speedily.

As there seems to be a very decided lack of knowledge as to just what these little "electric jitneys" are, this committee believes it well to briefly describe the common types in use.

The Tractor

Usually the tractor is not designed to carry cargo upon its body. Its whole purpose is to haul trailers, by means of which loads of incredible weight are easily drawn. Where the loads are extremely heavy or the roadway poor, the greater tractive ability of this type of vehicle will be instantly recognized—especially in the four-wheel tractor. One tractor will often displace from two to five horses in yard work, operating with much less care and supervision and costing less to operate than the feed of one horse.

Undoubtedly when long strings of express trailers have been seen being pulled through freight sheds or railroad warehouses or industrial plants it has caused wonder at the ease with which the little tractor at the head handled the load. However, to the initiated this ease of operation is no surprise as they know just how ruggedly and compactly these machines are built.

An excellent example of the brute strength of these "electric jitneys" happened just recently when a tractor pulled a string of 23 trailers weighing 4,000 lb. each, off of one of the Southern Pacific ferry boats at extreme

*Report of Transportation Bureau: E. J. Power, chairman; J. O. Case, H. K. Griffin.

low tide. This necessitated climbing a ramp pitched at a 45-deg. angle from the deck of the ferry boat to pier level. It is easy to imagine that it would be no trick at all for a machine that could pull as great a load as just mentioned, to pull a box car or two, and at various times they are called upon to do that very thing. It is a simple way to spot a car and can be done at the will of the operator without waiting for the switch engine. Besides these tractors, there are many other types of electric trucks for handling baggage, merchandise, and raw material in all kinds of industrial plants, storehouses and terminals.

Elevating Platform Trucks

The value of this type of electric industrial truck is recognized through its ability to use small platforms or skids. A skid is loaded (if desired, up to 6,000 lb.), the truck is run under it and at the touch of a lever, the base of the truck raises the loaded skid clear of the floor. The loaded skid is then delivered to the point desired to be unloaded, lowered, and the truck immediately withdraws from under the skid so that the truck is able to make another trip with a load to the point of delivery within a very short time. This method of hauling is not subject to delays incident to loading and unloading but can be kept in continuous operation. This type of truck is practically indispensable to any industry, as these and similar operations are continually repeated in warehouses, factories, and other manufacturing establishments. Today this type of electric industrial truck is used in over 250 branches of industry.

In the early part of 1916, the late Capt. William Matson, president of the Matson Navigation Company, and Capt. Charles Saunders, who was then general superintendent of that company, took a very active interest in reducing their stevedoring costs by means of electric industrial trucks. At that time there were very few electric industrial trucks in use in San Francisco, and even those in use had not been in use long. Therefore, almost no data were available, indicating what saving, if any, might be expected through the use of this comparatively new type of stevedoring trucks.

In order to gather more accurate data, a demonstration lasting several weeks was made to the Matson Navigation Company at Pier 28, and although a considerable amount of opposition was met with, the final result was that one truck was purchased for immediate delivery and three more were ordered to be delivered as early as possible. Some time elapsed after these first four trucks were put into service before extensive and general use was made of the trucks, but after two years of service, they seemed to have found very extensive use, and from that point on, the fleet was added to at frequent intervals.

One of the latest applications is using the trucks in the bottom of the ship's hold to bring the freight in much larger units up to the hook than heretofore was possible by hand methods. It is a well known fact that any kind of equipment suitable for general stevedoring work must be of a very rugged and substantial type, and further, that failures in service are serious on account of the value of the ship's time.

It is significant that electric industrial trucks and tractors are not only extremely simple in operation, making them a practical apparatus to put in the hands of the average longshoreman, but considering the very severe nature of the work which they are called upon to do, are of remarkably long life. Several of the electric trucks in the Matson Navigation Company's fleet have seen more than six years of service. There is also a considerable number of trucks owned by other steamship operators, which trucks have seen from five to seven years of service.

After the Matson Navigation Company had had the first four trucks in service for something like two years, and before they made extensive additions to their fleet, they determined that an average and fair comparison between the cost of moving freight by hand and electric truck methods be made. The results are shown in Table I.

In further explanation of the table, it will be noted that nine men were used; this is because the object almost universally sought for is to move the goods as quickly as possible, therefore using as many men as can be economically handled on any given job. It was found that in keeping the platforms loaded as fast as the truck could handle them that oftentimes from five to ten men could be used to advantage to keep one electric truck of the so-called elevating, or lift truck type, constantly busy moving loaded platforms. As a result of this a considerable portion of the electric trucks owned and operated by the several larger steamship companies in San Francisco who do their own stevedoring are of the lift type because of the comparatively greater amount of work which can be performed with this type of truck.

TABLE I
Electric Industrial Trucks vs. Hand Loading
Matson Navigation Company

	11 Men and Hand Trucks	9 Men and 1 Electric Truck
Time required	1 hr. 55 min.	1 hr. 10 min.
No. cases handled	1,050	1,140
Distance moved	500 ft.	400 ft.
Cars loaded	1	1
Cost	$13.20	*$7.05

*Includes all cost items—labor, etc., including depreciation.

After the above comparisons, both as regards time required and cost of handling freight by electric lift trucks as compared to hand methods, the Matson Navigation Company added to their fleet at frequent intervals until they are now operating thirty-six electric trucks.

Tier Lift Truck

There is a very wide range of usefulness for the tier lifting truck. Where containers are stacked in tiers or where trucks, box cars, etc., are to be loaded, this truck can be operated efficiently with the minimum of lost motion. The platform is raised to the desired height by power from the battery; then the truck is driven into position and the load is easily transferred. With this type of truck a 4,000-lb. load can be raised seventy-six inches in one minute, thirty-seven seconds. This machine, by doing the heavy lifting heretofore done by man power, makes the work of the men easier, thus reducing the labor turnover and accidents, which is a big factor.

Many factory executives have undoubtedly seen the little electrics in operation at railway terminals and have admitted they were a good thing, a necessity under present day standards of efficiency, yet they may not have realized that the use of similar trucks and tractors, perhaps a type more applicable to their individual requirements, might prove just as effective in their own plants as in the railroad terminal.

The Portable Crane Truck

The field of usefulness of this type of industrial truck is very broad and applicable to every industry where heavy parts or packages must be lifted. It lifts heavy members in erecting shops, places large castings on machine beds, and is an important tool for railroad shops and roundhouses for handling car wheels, steel billets, etc., difficult to handle by man power. It is pertinent to discuss the possibilities and the potential market for these vehicles. It is very difficult to determine the number of industrial vehicles in use at the present time, but from information gathered by the committee, it is believed that approximately 15,000 machines of all types are now operating. The efforts of the manufacturers in the past have been spent mainly in making straight, simple applications where no serious education or plant changes are involved, and regretfully so, as several times the quantity of vehicles now in use can be used economically without creating new types or making expensive plant changes.

Today a warehouseman may not be a buyer because his elevator is too small or light, his aisles too narrow, his roadway too soft, or his scales too small. However, he is sure to be a buyer in the near future as his business requires the handling of merchandise in volume. It is only a matter of time until this executive head finds an opportunity to make the changes necessary in his plant for the more efficient method of handling his commodity. The economic strife for his existence will force him to the use of labor-saving machinery and the electric industrial truck and tractor are the only kinds possessing the necessary flexibility for general use.

Central Station Interest

Twenty years ago, central station companies were selling practically no electricity for motive power purposes, while today there is being consumed over

200,000,000 kw-hr. of off-peak current per year. This considerably flattens out that valley which existed in the load curve and at the same time it returns a revenue, at 2 cents per kw-hr., of $4,000,000 per year, certainly a return worthy of serious consideration. A very large proportion of this revenue is produced by the electric industrial truck and tractor. The batteries vary with the different types of trucks and tractors and the service for which they are used, but a conservative estimate of the average amount of charging current required per truck per day is 20 to 25 kw-hr. or 6,000 kw-hr. per year. The total yearly consumption of 15,000 machines is, therefore, approximately 90,000,000 kw-hr. At a conservative power rate of 2 cents per kw-hr. the central station income from this source exceeds $1,800,000 yearly. This is off peak, high power-factor load which, of course, is several times as desirable as peak-load business from the net profit standpoint.

There are now in operation in California approximately 300 industrial trucks and tractors, as shown in Table II, and basing this number of trucks on the figures quoted above, the yearly return to the central station is approximately $60,000. As this is off peak-load, its value to the central station, from a standpoint of net profit per year, might be considered equivalent to a gross sale of $240,000 per year of peak-load current.

Central Station Assistance

While primarily the central station's business is the supplying of current and not the sale of electric industrial trucks and tractors, there is little doubt that they are in a position, without a great deal of expense, to contribute materially to the rapid growth of this industry by forming an electric truck bureau to use its influence on behalf of truck promotion. This bureau can readily disseminate information in the form of circular letters, active solicitation, etc., and other local means which will occur to a live man. The gross revenue from the sale of current used by an electric industrial vehicle throughout its life is about equal to the original cost of the machine.

As electric energy is the most efficient and economical power of the twentieth century, transportation service should be performed "ELECTRICALLY."

TABLE II.

Electric Industrial Tractors in Use in California

Steamship and municipal docks	70
U. S. Government in air service, navy yards, arsenals, army posts and docks	36
Food products	35
Brick and tile yards	26
Paints, oils and chemicals	24
Railroad shops and freight yards	23
Ship building plants	22
Iron, steel and wire works	13
Lumber industries	12
Warehouses	11
Express companies	9
Tractor manufacturers	8
Glass factories, moving picture plants, tire manufacturers, automobile manufacturers, flour mills, fruit packers, etc.	11
Total in operation in State of California	300

Some Facts About Street Lighting

By G. H. P. DELLMAN*

THE ever-increasing demand for street lighting has caused those who are responsible for the expenditure of public money to wonder if, after all, it is really necessary. Why should an appreciable portion of the community's funds be yearly spent on street lighting? In other words, why are streets lighted? While this at first seems a somewhat simple question, yet there are many people who are unaware what their street lighting system really means.

Primarily, streets were lighted as a protection against crime. It is a matter of record that over 98 per cent of all crimes committed on the street are after nightfall, and the majority of these in dark places. The better the street lighting, not only of the thoroughfares but also of the side streets and alleys, the better will be the police protection and the harder it will be for a crime to be committed and the criminal to escape under cover of darkness.

A proper street lighting system not only affords police protection, but prevents accidents. Everyone recognizes the necessity of the auto, and the consequent higher speed traffic conditions over those of a few years ago. This auto traffic naturally creates an accident hazard at night which menaces human life.

The immense value of high-speed traffic brought about by the use of automobiles has caused an enormous increase in traffic accidents. A careful study based on accident statistics from thirty-two cities shows that 17.8 per cent of all night traffic accidents are due to inadequate illumination. Evaluated, this represents an annual property loss of at least $54,000,000, in addition to human misery, loss of life and enforced care of dependents and those permanently disabled. On the other hand, according to census reports, the total expenditure for street lighting in the United States does not exceed $50,000,000 per year.

This was clearly demonstrated during the World War, when several cities who turned off their street lights to save fuel, turned them on again to save life and limb. During the period from 1917 to 1919, fatal accidents in the daytime increased only 6 per cent, while at night they increased 21 per cent. Similarly, non-fatal accidents increased 34 per cent in daylight and 63 per cent at night.

In the State of California the tremendous growth of automobile traffic is shown by the increased number of motor vehicles in use:

1920	532,934
1921	645,522
1922	823,594
1923	1,002,356

This shows clearly the changed conditions which demand that the streets of our cities be made safe and convenient at night.

It is significant, also, that property values the world over are considerably higher on highly lighted streets than on dark ones. In the cities of California wherever there exists a "White Way" or highly lighted street, property values exceed that of other business streets by thousands of dollars per front foot. Also, rental values are correspondingly greater. The reason is plain, when it is considered that people are attracted to a highly lighted thoroughfare and crowds will always be found on that street, and values of property are always dependent directly upon the number of people who pass.

Not always is the commercial aspect of property considered, but it is frequently more desirable to create beauty. This is particularly true of parks, boulevards and residence sections. If the avenue presents a bright appearance at night the surroundings are attractive. If darkness prevails, however, the architectural beauties of the structure are effaced completely and the section is shunned.

Review of Street Lighting Practice

Although there is record of primitive man using torches to light his path, the first authentic street lighting was practiced by the Romans, about 200 A.D., who suspended oil vessels with a wick, at the public squares. This was neglected in the middle ages, however, and it was not until the year 1524 that street lights again appeared, in Paris, when the authorities ordered a tallow light to be displayed from every window in certain streets. Tallow and oil lanterns and other improvements appeared in London and Berlin until the gas lamp of 1792, which was used until the advent of the

*Sub-Committee on Street and Highway Lighting: G. H. P. Dellman, chairman; R. H. Manahan, vice-chairman; H. H. Allison, Ray Conlisk, H. K. Griffin, O. J. Helvey, H. N. Johnson, C. E. Johnson.

first electric arc lamps in 1879 in Cleveland. These arc lamps consisted of sticks of carbon which emitted a very bright light when brought together in an electrical circuit. This was later perfected by surrounding the carbons in glass, which was known as the enclosed arc.

Ten years later the magnetite arc was invented, which differed from the arc only in the material of the electrodes. By using a composition material, the electric arc created gave out a far better light than was obtained from the carbon.

At about this time the carbon incandescent lamp made its appearance, but was not satisfactory for street service. With the invention of the Tungsten filament, however, a light could be obtained which was equal in every respect to that of the arc. Today the incandescent lamp is universally used, and is replacing the arc lights except in the great "White Ways" of the metropolis.

The early gas lamps were located on posts along the streets at convenient intervals, and men were employed to light them each night.

The first electric lights were suspended in a high tower, illuminating the entire area. As methods of distribution by wires were introduced, they were suspended over the center of the street at points where they were needed. Gradually, the incandescent lamps were used on a bracket from a pole suspended over the street in the same manner as the arcs. From this grew the custom of placing several incandescent lamps, enclosed in glass globes, on a post located at regular intervals along the street, which were known as "clusters." The perfection of the high power gas filled Mazda lamps made it possible to substitute one lamp in a decorative glass top on the post, in place of the cluster of lamps. This is our modern "electrolier" or "ornamental standard" system of lighting which is now being used by all progressive communities. In many places where the nature of the street does not permit the use of the standards, the "ornamental brackets" are used. This consists of adapting the electrolier tops onto the bracket attached to iron trolley poles, or the wooden poles on the street.

In "White Way" lighting, both the luminous arc and the high intensity incandescent lamps are used.

The development of the modern illuminants has brought several changes in the methods of wiring and most of the new systems are wired by what is known as the "series" system. This consists of one wire running through each lamp before completing the circuit, and results in considerable economy over the multiple system, which employed two or more wires. The series system uses a high voltage circuit and the multiple a low voltage, which is not as economically distributed to the lights.

Modern Practices

The foregoing explanation is intended to show the changes which street lighting systems have undergone in the past years, and will offer a ready explanation as to why so many types of street lighting may be found in the same city. Heretofore these cities did not have any definite plan of development, nor was much attention given to street lights. Consequently, every new political faction used the lighting system it saw fit, resulting in most cases in three or four different systems which did not harmonize or furnish correct illumination. Today, most communities have some definite plan of development outlined, which should be taken into consideration in planning any street lighting system. If no plan exists, then by all means one should be established to enable securing good street lights.

It is obviously undesirable to use the same street lights in a residence section as a business section, and vice versa. So the city should be classified for an intelligent scheme of lighting. This classification will naturally differ for smaller or larger places. For cities such as exist in the State of California, a suggested classification is outlined:

Class I—Cities of less than 1,000 inhabitants

(1) Main business street
(2) All other streets

Class II—Cities of 1,000 to 3,000 inhabitants

(1) Main business street
(2) Secondary business street
(3) All other streets

Class III—Cities of 3,000 to 5,000 inhabitants

(1) Main business street
(2) Secondary business street
(3) Boulevard or residential thoroughfare
(4) All other streets

Class IV—Cities of 5,000 to 10,000 inhabitants

(1) Main business street
(2) Secondary business street
(3) Residential thoroughfare
(4) Side streets of districts
(5) All other streets

Class V—Cities of above 10,000 inhabitants

(1) Main business street
(2) Secondary business street
(3) Boulevards or residential thoroughfare
(4) Side streets or residence districts
(5) Cross-town arteries and thoroughfares
(6) Wholesale or manufacturing districts (if any)
(7) All other streets

Main Business Street: The main business street should naturally be the brightest lighted street in the city, and the size of the city will govern the size and type of illuminants employed. As this street will bear the heaviest traffic, it should provide lighting which will afford safety and convenience to the public.

Secondary Business Street: The street system should be of the same general type, but need not be as highly illuminated as the main business section. The same spacing and type of equipment should be used, however, so that when this secondary business street develops to the point where conditions warrant, the higher power illuminants may be supplied.

Boulevards and Residential Thoroughfares: This section of the city will require some type of ornamental lighting which the surroundings will largely determine. If this street is very broad, the lights should be so placed as to illuminate the entire street surface and yet not cause a glare. The amount of illumination provided will be governed by the amount of traffic.

Side Streets or Residence Districts: Side streets and residence districts have much the same lighting requirements, and the function of the illumination of these streets is merely to afford police protection and safety. As there is not apt to be any traffic on these streets, the main consideration is that of lighting up the dark areas to a point where the pedestrian can discern objects at a distance.

Cross-town Arteries or Thoroughfares: Streets of this nature are found only in the larger cities and are, in effect, secondary business streets. At least they have considerable traffic and should be adequately lighted. A system of the same nature as suitable for the secondary business district will serve in these streets.

Wholesale or Manufacturing District: This part of the large city is usually deserted at night, but affords excellent opportunity for thugs and robbers. It is customary to place a very high powered light at intersection of streets and wherever necessary to light a dark area along the street front so that the pedestrian is not in danger of a person springing upon him from the shadows.

All Other Streets: These streets are for the most part residential, and should be lighted to a degree that will afford police protection and safety at crossings or other danger points. The streets falling in this classification comprise the major portion of the city and a definite plan should be adopted as to a uniform system. In general, the equipment used will not be as expensive and intensities will be lower than on the more important streets.

Essential Features of Proper Street Lighting

Of all the methods of street lighting which have been used, there are only three systems which are in use today:

(1) **The overhead system,** consisting of incandescent lamps suspended over the center of the street.

(2) **The pole bracket system,** consisting of incandescent lamps mounted on a support from a pole on the side of the street.

(3) **The ornamental standard system,** consisting of either arcs or incandescent lamps mounted on ornamental poles or brackets along both sides of the street, and equipped with decorative glass globes.

The center suspension system is used in the more important streets where the ornamental type is not employed. The light source may be of any size, and is suspended at a height of 20 to 25 ft. over intersections, in a manner that gives adequate light on all the streets at a considerable distance. This system has a distinct advantage over the type mounted along one side of the street, in that trees and shrubbery do not obstruct the light and create dark areas. Also, greater efficiency is obtained by overhead units than by any other type.

The ornamental type is used for "White Ways," business sections, parks, boulevards and other thoroughfares which justify the best systems obtainable. Any degree of decoration and light value may be obtained by this system, which is considerably more expensive to install than any other.

Any street lighting installation should conform to a predetermined plan, and be in accordance with the classification outlined above. Thus, whenever any changes or additions are made, old equipment may be used in other parts of the city and the new equipment will be the same as already in use.

Any street lighting system should be planned to give the desired light with the greatest economy. In some instances a few high candlepower lights will be more desirable than many small ones, and vice versa. The use of less than 2,500 lumen lamps is not recommended.

An overhead system will give adequate light in many instances where an expenditure for ornamental standards is not desirable. In providing light for side streets, proper sacrifice for intensity and decorative value must be made for the important thoroughfares. Proper heights and spacings must be observed with the surroundings in accordance with the economy involved. Thus a portion of a main thoroughfare may not resuire nearly such intensive lighting as the other end of the same street.

Due foresight must be taken to provide facilities which will take care of growth and improvements. Sufficient allowance must be made in the distribution system to supply current for larger lamps if desired. In ornamental designs, when initial expenditure is heavy, provision should be made to use higher candlepower lamps in the future without appreciable increased cost. It is customary to provide equipment which will take care of the lighting when the city has grown 50 per cent larger in population. The proper selection of equipment should be made in order that the desired effects will be accomplished. That is, proper light directing globes and refractors must be used for certain purposes, and again, certain heights must be observed to gain proper distribution of the light.

In general, the larger the light source, the higher from the street level it should be mounted. Wide streets also require higher mountings than narrow ones, to throw the light a greater distance. In the business and white way districts, the light should be directed to the front of the buildings as well as the street, while in the residence districts, light on the buildings is objectionable.

If then, as in some instances, upward light may not be as necessary and it is more essential to get the upward light down on to the ground, or in other words into the lower hemisphere as it is called, then a reflector or some other type of equipment for re-directing the light downward must be used.

The ornamental system of lighting utilizes four kinds of posts, (1) Cast iron, (2) Pressed steel, (3) Wooden pole, (4) Concrete. The cast iron post is extremely durable and readily lends itself to ornamentation. The pressed steel is light and flexible, and the posts serve as shock absorbers to the lamps and glassware. The wooden pole is extremely useful where it is desired to mount the ornamental brackets without the expense of the metal standards. The concrete post is desirable in some instances. The ornamental glass globes which enclose the light source and surmount the pole are manufactured in a multitude of designs.

In general there are three shapes of glass tops used in the ornamental standards:

(1) Urn shaped
(2) Acorn shaped
(3) Lantern or panelled

These shapes may be obtained in various densities of opal glass, or in rippled or rectilinear glass as desired. The opal glass diffuses the light in accordance with its density. The rippled and rectilinear glasses diffuse, but do not absorb as much light and give a sparkling effect. The following table gives a range of the absorption qualities of the various densities of glass:

Designation	Per cent Transmission	Per cent Loss
Clear	90 or more	10 or less
Very light density	85 to 90	15 to 10
Light density	75 to 85	25 to 15
Medium density	60 to 75	40 to 25
Heavy density	50 to 60	50 to 40
Very dense	50 or less	50 or more

The round ball globe which was used in the cluster system does not change the direction of the light, merely diffusing it, hence it is not used in modern systems. The various shapes outlined, each directs the light in a different manner and the individual case will determine the proper shape which is adapted to any degree of decorative value.

Methods and Financing of Street Lighting

If a corporate city desires to light the streets, the city government may spend as little or as much as it sees fit for that purpose. If certain portions of the city desire more lighting equipment than provided by the city, a lighting district may be formed under the law, and additional expenditures made in that district. If communities outside of corporate limits desire lights, they again have recourse to the lighting district. In the State of California there are three groups of statutes governing the formation of the lighting districts within corporate limits:

(1) Street improvement statutes providing for assessment upon a frontage or district basis. The "Vrooman Act of 1885," "Improvement Act of 1901" and the "Improvement Act of 1911," are in this classification, the latter being generally used.

(2) Taxing District statutes created for improvement purposes upon petition and vote of the district. The "Municipal Improvement District Act of 1915" and the "Municipal Tax District Act of 1919" come under this classification.

(3) Statutes creating districts by the City Council for improvement purposes. The "Acquisition of Public Utility Act of 1913" and the "Street Lighting Act of 1919" come in this class.

The provision for districts outside of incorporated limits is known as the "Highway Lighting District Act of 1909." There is quite a lack of definiteness in this act, which confuses the issues with the newly developed highway lighting systems.

Failures of the Past

It might be well to enumerate the most glaring faults of the existing street lighting systems, so that future installations may be thereby benefited.

(1) The most common mistake of the past is the inadequate amount of illumination.

(2) The lack of uniformity resulting in a miscellaneous lot of equipment which cannot be changed or improved.

(3) The leaving of gaps between systems in different sections and on the same streets.

(4) Lack of standardization of equipment and types.

(5) The tendency to make temporary and makeshift constructions which are dangerous and expensive to operate.

(6) Making provision for "moonlight" and "part night" burning, instead of designing the system to meet the available funds.

Traffic Lighting

There are various systems of lighting designed as an aid to congested traffic conditions which have proved the solution of very difficult situations. A system of traffic towers is used to utilize projectors which can be seen for a mile or two away, thereby regulating traffic on the entire street. The flood light is used to throw its beam on the traffic policeman, whereby his movements can be seen at considerable distance with ease. Flashing devices are used to denote safety zones and rail crossings, which are particularly useful to the strangers within the city. All of the many traffic indicating devices at intersections use lights for their effectiveness.

Highway Lighting

The tremendous increase in the number of automobiles in California, and the great system of highways, have created a situation which is rapidly growing acute. The highways are becoming more crowded and the speed greater. Also the headlight glare is becoming more and more of a menace to life and limb. The natural solution of this is the lighting of the highways with

highway lighting units. There are at present two successful lights manufactured for this purpose. These are also adapted for lighting long lanes and dark alleys where it is not practical to use street units. They throw a light a long distance and dispel the shadows where danger lurks.

Conclusion

A scientifically derived, comprehensive and far-sighted street-lighting program correlated with a city zoning plan, is not easily worked out. It calls for specialized talent in many lines of work, and in most cases city officials can profit by bringing into consultation the engineers found in the organizations of public utility companies, whose success depends largely upon their ability to foresee future requirements, and to meet them with a minimum loss in reconstruction. This nation is becoming possessed of many large cities, and most of them have in the past been more or less like "Topsy,"—they just grew.

APPENDIX A

In order to assist in the proper laying out of street lighting systems, this Committee has prepared the following data:

(3) If the street lighting appropriation is more than sufficient to meet the conditions of (2), increase the size of light unit on important thoroughfares to 4,000 lumens.

(4) If the appropriation is more than sufficient to meet the conditions of (3), increase all the units to 4,000 lumens.

(5) If the street lighting appropriation is more than sufficient to meet the requirements of (4), install intermediate units of 2,500 lumens on all blocks of the built-up districts in length exceeding 20 times the mounting height (two intermediate units if lengths exceed 32 times the mounting heights).

(6) If the street lighting appropriation is more than sufficient to meet the conditions of (5), increase all intersection units to 4,000 lumens.

(7) If the street lighting appropriation is more than sufficient to meet the conditions of (6), increase all intersection units to 6,000 lumens.

(8) If the street lighting appropriation is more than sufficient to meet the conditions of (7), provide a spacing of eight times the mounting height on all important traffic streets within and without the built-up district, using thereon 6,000 lumen intersection lamps and 4,000 lumen intermediate lamps within the built-up district and 4,000 lumen lamps throughout, outside the built-up district.

(9) If the street lighting appropriation is more than sufficient to meet the conditions of (8), provide a spacing of eight times the mounting height throughout the built-up district. Use 6,000 lumen lamps for all intersections, and 4,000 lumens for intermediate units.

(10) If the street lighting appropriation is more than sufficient to meet the conditions of (9), employ 6,000 lumen lamps throughout at the 8-times-the-mounting-height spacing.

RECOMMENDED PRACTICE IN ORNAMENTAL STREET LIGHTING SYSTEMS

Type Street	Size Unit Lumens	Number Lamps	Mounting Height Ft.	Spacing Distance Ft.	Hours Burn	Operation Paid For
Parks	2,500	Single	12 to 15	100 to 150 Staggered	A.N.	City
Boulevards and Residence	4,000 6,000 Luminous arc					
Secondary Business and Traffic Thoroughfares	4,000 6,000 Luminous arc	Single	13 to 16	100 to 150 Staggered or Opposite	A.N.	City
Main Business Streets	4,000 6,000 10,000 15,000 Luminous arc	Single or Double	13 to 18	80 to 125 Opposite	A.N. or A.N. and M.N.	City
White Ways	10,000 15,000 25,000 Luminous arc	Double	18 to 24	80 to 125 Opposite	A.N. and M.N.	City and Property Owners

Ornamental systems should operate on a flat monthly rate including renewals, operation and maintenance by the public service company. Ornamental lighting standards should be installed and owned by the property owners; underground distribution system should be installed and owned by property owners or power company as desired by the interested parties. Ornamental lighting standards should conform to architectural structure of buildings, width of streets, and character of communities.

Foundations should be of sufficient weight and size to support safely in an erect position the standard to be installed. Minimum size for solid concrete is 24 in. x 24 in. x 30 in.

Lamp Renewals

Very careful study has been given to the matter of lamp renewals, and there seem to be no definite data at hand for determining when a lamp has reached its useful life. Most of the utilities serving street lighting systems where they are responsible for maintenance, do not renew lamps until burn-out occurs. If we are to create a favorable impression and keep the good will of a community, this practice should be discontinued.

This Committee is not prepared to offer a scientific method for determining when a lamp has reached a predetermined loss in efficiency, but it believes that it is practical to do this by experienced observation. This will at least forestall criticism by the inexperienced observer.

Mounting Heights

As this Committee has recommended against the use of less than 2,500 lumen lamps, these recommendations are based on lamps of 2,500 lumens or over.

2,500 lumen lamps	20 to 25 ft.
4,000 lumen lamps	25 to 30 ft.
6,000 lumen lamps and over	30 to 35 ft.

Where bracket types of fixtures are used, care should be taken to mount them so that the reflectors are mounted in a horizontal plane.

Cleaning

Definite schedules for cleaning should be adopted, these varying with different localities.

Recommended Practice for an Overhead Street Lighting System

APPENDIX B

(1) Lamps of less than 2,500 lumens (250 cp.) are not economical when used for street lighting. The cost of lighting is about one-third more than the next smaller size, i.e. 1,000 lumens (100 cp.) and the effective illumination two and one-half times greater.

(2) Do not use a lamp any larger in size than 2,500 lumens until a light unit of this size has been provided for each street intersection in the built-up district, for each point where a street crosses a steam railway at grade, and on a 15-times-the-mounting-height spacing along each important traffic street outside the built-up district.

APPENDIX C

In general there are three groups of state statutes under which a lighting district may be formed in incorporated cities of California. These statutes also apply to chartered cities unless other provision is especially made in the charter.

(1) Street Improvement statutes providing for assessment upon a frontage or district basis. The "Vrooman Act of 1885," "Improvement Act of 1901," and the "Improvement Act of 1911" are in this classification, the latter being generally used.

(2) Taxing District statutes created for improvement purposes upon petition and vote of the district. The "Municipal Improvement District Act of 1915" and the "Municipal Tax District Act of 1919" come under this classification.

(3) Statutes creating districts by the City Council for improvement purposes. The "Acquisition of Public Utility Act of 1913" and the "Street Lighting Act of 1919" come in this class.

Class I

The "Vrooman Act of 1885" and the "Improvement Act of 1911" are very similar and provide for the installation of a lighting system, but not for its operation. Under these two acts the legislative body of an incorporated municipality may take the necessary steps to establish a street lighting system "Whenever the public interest or convenience may require."

These two acts provide two alternative methods of assessment and two alternative methods of payment. The assessment may be either according to frontage or according to the district benefited. Assessments may be paid within thirty days, or bonds may be issued against the assessed property in accordance with provisions in these acts. The "Improvement Bond Act of 1915" which can be used in conjunction with either act, provides that all property subject to assessment is subject to a lien for payment of all bonds, whereas the other acts provide for the issuance of bonds against individual pieces of property.

The general procedure under these acts follows:

(1) The council must pass a resolution of intention to do the specified work.

(2) Notices must be posted and published for a couple of weeks.

(3) Hearing shall be had before the council of all property owners who have filed written protests, and who will be subject to assessments for the proposed installation. Protest by those representing a major portion of frontage or district will postpone all further proceedings for at least six months. (However, under the "Improvement Act of 1911," three-fourths vote of the council may over-ride such opposition.)

(4) Advertisement for contract bids.

(5) Bids opened. If all rejected, the council must re-advertise. The "lowest responsible bidder" shall be accepted.

(6) Notice of award of contract shall be posted and published ten days.

(7) Property owners subject to assessment may, within ten days, undertake to do the proposed work on the same terms and conditions as awarded the lowest bidder.

(8) Contract must be entered into within ten days, and work begun within fifteen, by contractor.

(9) Assessment shall be apportioned and filed against property.

(10) Council shall hear protests for inequitable assessments. Council's decision is final.

Class II

The "Municipal Improvement Act of 1915" and the "Municipal District Tax Act of 1919" are very similar, with the following distinction. The first provides a bond issue for installation only, whereas the latter provides for installation and operation for a period of one to five years, the officers of the municipality acting for the district. The tax under the Act of 1919 is limited to 35c. per annum for every $100 of property valuation.

The general steps in the procedure under these acts follow:

(1) Petition of 10 per cent of the qualified electors of the proposed district, specifying the proposed improvement and the boundaries of said district, is filed with the city council.

(2) The city council may thereupon pass an ordinance, declaring its intention to call an election of said district for raising the necessary funds, stating the boundary of the district, the improvements, the date of election, and date for hearing protests.

(3) Notice of said ordinance to be posted and published.

(4) Hearing of protests to be had before council, whose decision is final. If any protest is sustained, further proceedings are postponed for six months.

(5) The boundaries of said district may be modified by the council by publication and hearing of all protests, not less than ten days after the publication of the resolution to modify.

(6) The election. The council shall divide the proposed district into one or more precincts for such election.

(7) Special tax shall thereafter be levied against property in this district.

(8) Contracts to be let.

Class III

The "Acquisition of Public Utilities Act of 1913" and the "Street Lighting Act of 1919" are very similar, with this distinction: the Act of 1913 provides for installation and operation for a two-year period, whereas it is doubtful if a street lighting installation can be made under Act of 1919, but it definitely provides for operation for five years for those systems already installed.

The general steps of procedure under these acts follow:

(1) Resolution of intention passed by council.

(a) Specifying extent of district to be benefited and against which assessments shall be levied.

(b) Proposed improvement.

(c) Directing a report from a certain board, or officer of improvements, or engineer, to be designated by the council.

(2) The report of said board or officer of improvements or engineer, which shall specify:

(a) Plans and specifications of proposed improvements.

(b) Estimate of cost.

(c) Diagram of assessment district.

(d) Proposed assessment against respective property, proportional to benefit.

(3) Report considered by the council and any modifications made.

(4) Notice of acceptance, or modifications, to be posted and published.

(5) Hearing not later than twenty days thereafter of any protests by property owners within the district.

(6) Assessments levied. Any contest of assessment to be made within thirty days thereafter, and appeal therefrom within thirty days more. The assessment is a lien upon the property, subject to sale for delinquent payments and redemption by owner.

(7) Council may advance moneys from the general fund to expedite making of any such improvements, which advancement shall be refunded from assessments collected.

(8) Contract let to lowest responsible bidder, after transfer of assessment role to tax collector.

(9) Proceedings may be abandoned by the city prior to letting of the contract.

Where it is desirable to form a lighting district for installation and operation, it can be accomplished in two ways: First, install the system under one act and provide for its operation under another; or, second, provide for its installation and operation for one to five years under one act, at the expiration of which time the city council can re-establish the district under a different act which might be more convenient or desirable.

APPENDIX D

The "Highway Lighting District Act of 1909" is one statute clearly applicable for lighting districts in territory outside of incorporated cities. This act is limited in its operation strictly to towns and villages, and does not include farming districts. Just what constitutes a village is not known, but several stores and houses at a cross-roads would probably qualify. A post office at such a location would remove any doubt in the matter. With the advent of highway lighting units, some action should be taken to clarify this subject.

Under this act, the steps in the procedure follow:

(1) Petition of 25 taxpayers and residents of said town or village presented at a regular meeting of County Board of Supervisors, specifying name and boundary of proposed district.

(2) Board of Supervisors to fix date of hearing 25 to 30 days thereafter.

(3) Notices by clerk to be posted at once in three public places and published for two weeks in a newspaper, concerning such petition and the date set for hearing thereon.

(4) Persons objecting to formation of such a district may file written protests to the same.

(5) Hearing of said protests, the Board's decision thereon being final.

(6) Resolution by Board of Supervisors within 30 days thereafter, providing for election within 30 days, and appointing three electors to conduct same.

(7) Three notices to be posted, and publication for 15 days, concerning proposed district, and date and places for election.

(8) Election on acceptance or rejection of said district.

(9) Resolution by Board of Supervisors establishing district (provided such vote carried).

(10) Board of Supervisors shall act for the lighting district, advertise for bids, let contract of installation, and provide for maintenance.

(11) Tax levy shall be estimated September 1 of each year, levied and collected against property within district like any other tax.

(Provisions are also made for alteration, enlargement, or abandonment of district.)

Residence Lighting

By CLARK BAKER*

IN order to determine to any extent the present practice in residential lighting, a survey of 1,500 middle class homes was made. These homes were representative groups from a number of cities throughout the country. The survey reveals the influence of rental and of ownership, on the wiring and lighting equipment. It shows the average rented middle-class home consists of slightly under six rooms, and the average "owned" home slightly more than seven rooms. The rented home has less details in wiring, fixtures, portables, convenience-outlets, etc., than the owned home.

In order to put these data on a comparable basis a modern middle-class home was designed and adequately wired for lighting and convenience-outlets to bring out the degrees of saturation of various items of wiring and equipment in this class of home. All items except ceiling fixtures were less than 50 per cent of what they should be. The chief deficiency is found in the convenience-outlets per home, likewise outlets for brackets. The deficiency in lighting equipment is chiefly found in lack of shades, wall brackets and portables. It likewise was found the wattage per socket was low. From 12 to 38 per cent of the wall brackets found were without shades. From 7 to 21 per cent of the ceiling fixtures had no shades.

The survey may be summed up approximately as follows: One-half of the population live in places larger than 2500 inhabitants. About two-thirds of the homes within reach of electricity are wired. One-half of the homes are rented. The middle-class home is less than one-half lighted.

That portion of the survey which extended into low-class homes brought out that they were less than one-half as well lighted as the middle-class home.

Recommendations of Standards to be Worked To

The average home may be wired and equipped in various ways. The following, however, are general descriptions submitted for this committee's recommendations. No detailed description of fixtures, portables, or side brackets is presented. It is assumed these will be equipped with proper shades, however.

Living Room

General lighting from a shower, or from "direct-indirect" portables, could utilize 200 watts. A table-lamp, a floor-lamp, a small piano or desk lamp, and two small decorative portables can account for 340 watts. This is a total of 540 watts, all of which of course, would seldom be used at one time. If decorative brackets were used the general lighting or decorative portables might be reduced accordingly. Three convenience-outlets are specified.

Dining Room

In the case of a shower, lamps aggregating 150 to 200 watts in deep dense shades could provide general lighting, and from 30 to 100 watts in decorative portables or brackets. A total of 230 watts is assumed to be desirable. One convenience-outlet is specified.

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Kitchen

A 100 watt lamp in the central fixture is assumed to be a desirable average. This would be a 150 watt if a "daylight" lamp is used. Two auxiliary brackets or other sockets would easily account for 80 watts. It appears safe to assume a total of 180 watts as desirable. One convenience-outlet is specified.

Bedroom

A central fixture using 50 watts, two brackets or dresser lamps using 50 watts, and a bed lamp of 40 watts makes an aggregate of 140 watts. This wattage may easily be distributed in two brackets and a portable without considering a ceiling-fixture. One convenience-outlet is specified in each of three bedrooms.

Bathroom

One bracket on each side of the mirror and each containing a 50 watt lamp accounts for 100 watts. One convenience-outlet is specified.

Basement

Assuming a 100 watt lamp or a 150 watt "daylight" lamp over the laundry trays and four other outlets distributed in locker, over work-bench, near heater, in coal bin, in toilet, etc., it is easy to account for a total of 300 watts.

Convenience Outlets

A total of nine is assumed, thus providing an average of one per room with two extra for the living room.

Portables

A total of eight is assumed; these include the small decorative portables.

Wall-Brackets

A total of nine is assumed; these can easily be accounted for from a purely utilitarian standpoint without considering any decorative brackets in the living or dining-room. Two in each bedroom, two in the bathroom, and one in the kitchen account for nine.

Ceiling Fixtures

An average of one per room is quite, if not more than sufficient.

Total Wattage

A total of 1,770 watts in these various rooms is assumed.

Note that no mention is made here of hall-ways, porches, etc. Only the living-room, dining-room, kitchen, bedrooms, bathroom, and basement enter into the values presented.

Ways and Means

There should be in the hands of all sales organizations, power companies, jobbers, manufacturers, fixture manufacturers, contractors and dealers, educational material on the proper voltage of lamps. There should be brought to the attention of all sales organizations, power companies, jobbers, manufacturers, fixture manufacturers, contractors and dealers, the work of the Illuminating Glassware Guild, also the position of the fixture manufacturers in lighting design.

There should be worked out and promoted in all sales organizations, together with architects and builders, a revision of their present order of things when it comes to the lighting of the home. By that is meant, instead of starting at the entrance switch, carrying the wires throughout the home and finally end by putting only one outlet in a room, start with the kind of light and amount of light which will be required in each room consistent with the architectural design and color scheme, thereby fixing the number of outlets required in each room, then gather these up as they go along, finally working to the entrance switch. In this way, decorative fixtures, architectural design, subdued light (which doesn't materially mean less light) color effects, etc., can and will be encouraged with a greater degree of safety due to proper wiring. Three per cent of the cost of the house should be allowed for permanent lighting fixtures, an additional 3 per cent for wiring of lighting and convenience-outlet circuits.

The Improvement of Industrial Lighting

By G. E. ARBOGAST*

LEADERS in the electrical industry, particularly those interested in higher standards of illumination, realize the urgent need of coordinating the efforts of all branches of the industry in the inauguration of a campaign to sell the idea of better and more efficient lighting in our industrial plants. Toward that end this paper is written and it is divided into the following subjects:—Present Practices; Suitable Standards; Ways and Means of Selling this Standard.

The distinct trend (during the last ten years) toward higher intensities in the lighing of areas indicates clearly that the benefits of proper lighting are gradually becoming recognized. The average progressive operator no longer considers illumination as a necessary evil but views it in its true light as a vital necessity and as something that represents not an unavoidable expense, but an investment which will effect a minimization of accidents, increased productive capacity and economies in manufacture. There still remains, however, marked room for improvement both in the increasing of intensities and modernizing of equipment, as pace has not been kept with the rapidly rising standards and improvements in equipment.

Much has been said in the past regarding the production increases made possible through the elevation of lighting standards. For example, in many areas of the steel mill and foundry, production increases under good lighting, as compared to poor lighting, are made possible through the facilitation of the movements of the workers, increase in speed and accuracy of visual perception, better supervision in and about plants, and reduction in spoilage. With other factors remaining unchanged, an efficient system of lighting renders continuous operation practicable throughout the twenty-four hours, thus doubling the working time and consequently the output. Furthermore, the cost per unit output is greatly reduced since fixed charges are distributed over twice the tonnage.

Present Practices

Lack of information on the part of factory executives about lighting and its importance to a properly conducted plant, perhaps more than anything else, is responsible for the 70 per cent or more of our industrial plants that are inadequately lighted. Unfortunately, this applies not only to the existing plants, but also to new ones being constructed every day. Bare lamps on drop cords are commonly used, with their attendant abuses, blinding glare and severe contrasts. Bare lamps on wide centers mounted directly on ceiling outlet-box receptacles are frequently relied upon to provide the illumination on the working planes.

These practices are natural tendencies on the part of the uninformed, for the first cost is obviously less. Sooner or later, however, the fallacy of skimping will become apparent to the management, but often too late. The wiring is in, but the capacity for increasing the lamp wattage to bring the system up to a proper standard is not there, and there is a common stumbling block to the application of a remedy to an old installation. A big step towards the elimination of this has been the establishment in some localities of ordinances requiring the provision for a certain "watts per sq. ft." wiring capacity—a rule which safeguards to some extent the factory management, especially of a lessee of factory space, against the embarrassment of large future expenditures in revamping the wiring to provide for the necessary added wattage.

Considerable improvement in lighting installations in industrial plants is noticeable covering a three-year period. It is safe to say that 50 per cent of new installations are designed to use modern equipment but sufficiently high intensities are neither recommended nor

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installed. The other 50 per cent are considerably below any standard, in many cases even below the minimum of the state law. Many industrial plants using loft buildings are particularly under-lighted. A much more extensive use of the RLM dome reflector is noticed but still there are many installations where the flat-type reflector is used. A not uncommon mistake in illumination design is in the installation of larger and fewer units instead of smaller and more units.

There are still found many installations installed three years ago and before, that are now obsolete, and a large percentage of these installations is still using bare lamps. There are approximately 15,000 manufacturing plants in California, and 50 per cent of these are of sufficient size to warrant an adequate illumination design. It is found, however, that about 55 or 60 per cent of those who should have adequate lighting are still badly in need of it. It is likewise found that approximately 50 per cent of these plants are either only partially equipped with reflectors or are without reflectors at all.

Among the smaller manufacturing concerns—that is, concerns employing from 25 to 50 or 75 men—it is estimated that about 35 or 40 per cent of the plant owners are unfamiliar or vaguely familiar with illumination and its value as to increased production, decreased spoilage and prevention of accidents. In the larger manufacturing plants it is found that approximately 80 per cent of the plant owners are familiar with illumination and its value. This brings out clearly the need of more intensive selling because of the fact that while 80 per cent of the larger plant owners are familiar with the value of good illumination, still from 55 to 60 per cent need better illumination. In other words, they know its value but have not been sold.

Suitable Standards

Though there are three or more distinct types of reflectors used for industrial lighting, the most common and that accepted as the most satisfactory for all general purposes is the RLM standard dome reflector. This together with a bowl enameled Mazda "C" lamp properly chosen as to size and correctly installed as to spacing and mounting height will, in general, give all that might be desired for a first-class industrial lighting installation.

High intensity general lighting, except in isolated cases, should be used rather than localized lighting; and, where localized lighting is necessary, its use should be merely supplementary to that of the general system. This last is important in that the contrasts in illumination resulting from the use of local lighting will usually be found so harsh as to be objectionable even though the lamps themselves are well shielded.

The lighting intensities recommended by various authorities agree in the main. It is interesting, however, to note the tendency during the past few years towards higher levels, a tendency which still persists. It is our opinion that in making a recommendation on intensities it might be well to set a definite value rather than to state a range as, for instance, 6 to 12 foot-candles which, it is felt, gives too much latitude to the judgment of the individual.

It is the desire of the committee to follow as nearly as possible the work that has already been done by the industry and no data have been compiled that more fully fit the condition than that covered in engineering bulletins issued by the leading lamp manufacturers. The following is quoted from one of these:

"Factory interiors are usually divided by columns into bays, or rectangles, of uniform size, and such bays afford a convenient starting point in determining the location of the lighting units. It is desirable that the lighting units be symmetrically spaced throughout the whole of an interior and this will result if the units are properly spaced in each bay. Furthermore, a correct lighting design presented in terms of individual bays can be readily extended throughout a plant of only a few or of many bays.

"Many times in interiors where there are no columns, the arrangement of beams on the ceiling, or trusses, will suggest a natural division into bays, which can be used in comparing the actual interior with the ready-made designs. Attention is called to the fact that large bays can frequently be split up into a number of smaller bays corresponding in size to some one of the common sizes. Furthermore, where there are no structural features suggesting bays of suitable sizes, any of the specifications in which the ceiling height corresponds with that of the factory under consideration may be duplicated.

"The more experienced the illuminating engineer, the less he feels inclined to give general figures as to how much light any factory operation requires, for he realizes that much depends upon individual conditions. He has no hesitancy, however, in stating that more light than is generally used today may be used economically and profitably. Recent years have seen a large number of factory managers make a careful scrutiny of the facts regarding lighting and then put in four, five or six times as much light as they had previously considered an adequate amount.

"Daylight outdoors, in the shade on a sunny day, will measure about 500 foot-candles; the usual run of factory interiors will measure under artificial light in the neighborhood of 2 or 3 foot-candles. Obviously, in a well designed artificial lighting system there is little likelihood of there being such a thing as too much light.

"There are four general levels of illumination which the designer of a lighting system will do well to keep in mind:

"**5 foot-candles.**—Satisfactory for work of a coarse nature, such as rough assembling, rough packing, coal and ash handling, and the like, where the eyes are not called upon to see small details quickly and accurately. This value also would represent an abundance of light for warehouses, stockrooms, and aisles and passageways which were always kept free from obstructions. Enough light to dispel any sense of gloom.

"**10 foot-candles.**—Considered good lighting for most kinds of work on light-colored surfaces, and for fairly close work on dark surfaces. Not enough light for examining fine details on dark, light-absorbing surfaces.

"**15 foot-candles.**—Really excellent lighting. In addition to permitting quick and accurate execution of all work except the most exacting, lighting of this kind stimulates the workman and makes for fast and accurate production.

"**50-100 foot-candles.**—The upper range of artificial lighting values as judged by present experience. Necessary only in extremely fine, accurate operation and in inspections of very fine details.

"The arrangement of lighting units as described herein represents lighting practice which is up-to-date in every respect. All the important factors, such as light from several directions reaching the work at all points, uniformity of lighting, shadow, and freedom from direct glare have been given due consideration. In estimating the foot-candles illumination, average conditions have been assumed. Foot-candle values for small and large interiors are given, for the size of the room has a material effect upon the illumination obtained. In the usual types of factory interior, the reflecting condition of the ceiling and walls has relatively little effect on the actual foot-candles at the work where RLM reflector units are used. This does not mean, however, that it is not necessary to keep the walls and ceiling light and clean, for upon their ability to reflect light back into the room depends largely the bright and cheerful appearance of the interior.

"In the foot-candle and wattage values given, allowance has been made for average normal depreciation in service. It is important that the cleaning of equipment be put upon a systematic basis in order that the illumination may be maintained at a level which will insure economical production. Frequently, some type of disconnecting hanger which permits the units to be lowered to the floor can be used to good advantage."

From this rather long extract it is easily observed that these bulletins have covered the subject in detail. The committee would, however, make two supplementary suggestions or recommendations.

First. In laying out a lighting system for industrials housed in buildings where the wiring is concealed, such as loft buildings, or where the wiring can not easily be changed or additions made thereto, we recommend that provision be made for a minimum intensity of 15 foot-candles, even though the present tenant may use but a part of such capacity. It is our belief that lack of capacity in the wiring prevents the use of the higher intensities, and the cost of changing concealed or inaccessible wiring is often almost prohibitive.

Second. It is recommended that tables be provided converting foot-candle intensity to watts per sq. ft. for various mounting heights and spacing of lighting units. This table would be approximate only, but would enable the contractor to quickly determine whether the system he was installing was of suitable capacity, which he might not be able to determine if he had to use foot-candle terms. A rough specification illustrating this point follows:

SPECIFICATIONS

Bays, 20 ft. x 20 ft.	Mounting height, 10 ft.
Ceiling height, 12 ft.	Equipment:
Units per bay, 4.	RLM standard dome reflectors with
Spacing, 10 ft. x 10 ft.	bowl enamel Mazda lamps.

Wattage per outlet 100 foot-candles, 5
Wattage per outlet 200 foot-candles, 10
Wattage per outlet 300 foot-candles, 15

Ways and Means of Selling Suitable Standards

As pointed out above, the great lack of adequate lighting in factories is largely due to the need for information. It is quite apparent, therefore, that one of the outstanding means of selling a proper standard is through education, not alone of the industrial management, but of the man who attempts to sell it as well. In other words, it is necessary that the one who undertakes to sell the factory manager proper lighting know his line. Unfortunately, too often either in his eager-

ness to sell his product or through his ignorance of the essentials of good lighting practice, he leaves the customer but little better off than before.

The steps in the conception, design, and construction of an industrial plant, however, are several, and selling the lighting standard can generally not be left until a time when the owner is ready to talk and consider the purchase of the equipment. There is first the architect or engineer who plans the building and writes the specifications. The education should properly begin here. Next, the electrical contractor who installs the job needs to know the importance of adequate industrial illumination, and to know the essentials for planning a proper system to meet the responsibilities which the architect may have failed to meet. Next comes the supply man or jobbers' salesman, who in his daily contact with the electrical contractor, has the opportunity to guide him where such contractors can not measure up to the task of carrying the necessary information to the owner. In other words, the education must start within the industry itself, and with the established standards of equipment and simple rules of application, this education lies within easy reach of any one who wishes to give the subject a small study.

One of the actual ways and means of selling a proper standard, assuming that the industry is equipped with a knowledge of the subject, is actual demonstration. Especially is this effective on old jobs where entry has been effected. The use of samples installed free in a bay in such a manner that there is a marked contrast between the old job and a proper one, generally results in the sale of the sample installation with an order for similar equipment for the remaining space.

The use of photographs of actual installations is most effective in picturing to the owner what his plant would look like under proper lighting conditions. He very frequently asks if there is a good installation in the city or near at hand that he might look at. A list of such installations to which he might be referred, therefore, lends itself well. As the specialist becomes active in his work, he will have local experiences with the advantages of good illumination and will be able to use them most effectively in talking with his prospects.

The man who hopes to sell lighting to plant executives must be able to talk forcefully and authoritatively on its proved advantages and the money value of good light in the larger return in both quantity and quality of work which will result from the installation of a superior as compared with an inferior lighting system. Data and information to this end will be found in the Proceedings of the National Electric Light Association, the Transactions of the Illuminating Engineering Socity, and elsewhere.

The importance of enlisting the cooperation of all electrical interests in the community can scarcely be over emphasized. All classes of material and equipment, as well as labor are involved in a greater or less degree in the installation of a new system or the remodeling of an old one.

The central station, by virtue of its constant connection with the industries, is the largest factor in the lighting situation and should take the leadership in selling the idea to the other organizations. Speakers on lighting should be provided to talk before various executives' groups, contractors' meetings, as well as architects' and designers' gatherings. Intensive campaigns conducted jointly by central stations, manufacturers, jobbers, and contractors have great possibilities, both in popularizing the need for better illumination and in the actual selling of installations.

More publicity should be given the State Lighting Code. Though the minimum intensities required under this Code are decidedly inadequate, recommended values are also given which are more nearly desirable. The fact, alone, that proper lighting is important enough from just the standpoint of the health and safety of employees to warrant state legislation, commends attention.

Educating the Industry

Too often papers on subjects like this deal in generalities and do not make definite recommendations. This committee has gone further and suggests that schools be established in at least three localities; namely, Northern California, Southern California, and the San Joaquin Valley, in which a course on illumination design would be given. This course should cover the basic and fundamental facts of illumination by easy, simple, calculating methods, so that the student will have a training which will permit him to lay out a practical installation for either commercial or industrial lighting, that will take care of at least 80 to 85 per cent of the cases. This course could be concentrated and given in a week or spread over several weeks as decided upon by those interested in each locality.

In these schools there should be as many men from their sales organizations as the central stations can allot. There should be at least one man from each jobbing and manufacturing organization, and as many more as may be arranged. The contractors should send as many of their men as come in contact with illumination problems. It may be thought wise to have the architects' offices and consulting engineers represented.

The curriculum is already established, as such schools have been conducted elsewhere. A suggested list of subjects follows:

Demonstration of lighting fundamentals; simplified methods of designing illumination; the use of educational publicity; engineering bulletins; trade paper articles, etc.; economic interpretation of lamp tests; development of improved lighting equipment; illuminating engineering recommendations of industrial plants, offices, stores, public buildings, streets; special lighting designs; candle power standards; foot candle meters and intensities; special industrial lighting requirements; lighting economy; special lighting problems (examples); preparation of plans and specifications for lighting; principles of light reflection and diffusion; choice of lighting equipment; lectures and demonstrations on residence lighting; possibilities of light and color; street lighting; suitable standards for street lighting; selection of equipment for street lighting; intensities for residential section and business section; store lighting; show window lighting; commercial and public interiors; requirements of school lighting; lighting practice and the illuminating engineering society; design of illumination for offices and drafting rooms; practical design of general lighting for industrial operation; Mazda quality; a lighting salesman's responsibility; manufacturing service by the lamp and reflector manufacturers.

The establishment of these schools in the fall, preferably in October, has already been anticipated and a budget has been submitted to the executive committee of the Pacific Coast Electrical Association for funds necessary to operate such schools.

It is believed that the Lighting Bureau should be charged with the responsibility of establishing these schools and are satisfied that there are enough interested men in the industry to conduct them, who know the subject thoroughly and are willing to give their services for this work.

Annual Lighting Months

In order that both the industry and the public may receive the greatest benefit from the educational work done in the schools, we recommend that November of each year be set aside as Lighting Month.

During that month an intensive campaign should be prosecuted to get the idea of the need for more and better light before the public, particularly commercial and industrial establishments. To accomplish this the industry should maintain a speakers' bureau and make every effort to be represented on the programs of such clubs as Rotary, Kiwanis, Soroptimist, etc., where the story should be told with suitable visual displays. All branches of the industry should cooperate in every way possible in order to secure effective results. All local advertising should be tied in with this campaign, and if possible cooperative page advertising should be used to secure from the press desired publicity in their news columns.

The committee believes that the Lighting Bureau should be charged with the responsibility of conducting this campaign.

Recommended Standards for Commercial Lighting

By H. H. COURTRIGHT*

THE objective set for itself by the Commercial Lighting Committee this year specified three definite accomplishments. As all work and discussions were carried on with these three points in view the results of the committee's efforts can best be laid down under these respective headings:—

*Sub-Committee on Commercial Lighting: H. H. Courtright, chairman; S. H. Anderson, H. H. Allison, G. H. P. Dellman, Leonard Hobbs, Fred S. Mills, David Pence, Frank Smith, A. L. Spring.

1. The determination of present practices and existing conditions in commercial illumination on the Pacific Coast.

2. The recommendation of standards of intensity toward the establishment of which the entire industry shall be urged to work for the general welfare of all.

3. The recommendation of certain specific means whereby the above standards and the value of adhering to them, may most effectively be spread broadcast to all interested parties.

Present Practices.

The following figures, obtained in a recently made coast-wide survey of retail stores are exemplary of conditions as they exist today:

10 per cent had an average interior intensity of 10 foot-candles or better.

28 per cent had an average interior intensity of 5 to 10 foot-candles.

62 per cent had an average interior intensity of less than 5 foot-candles.

Approximately 60 per cent of the installations were direct lighting; 25 per cent semi-indirect (totally enclosed glass units); and 15 per cent had bare lamps.

5 per cent had a show window intensity of 40 foot-candles or better.

10 per cent had a show window intensity of 15-25 foot-candles.
20 per cent had a show window intensity of 10-15 foot-candles.
65 per cent had a show window intensity of 5 foot-candles or less.

The 15 per cent of the two upper classifications were using color, spotlighting and floodlighting. Of the 65 per cent with a show window intensity of less than 5 foot-candles at least 35 per cent were using bare lamps, the remaining 30 per cent using direct or semi-indirect ceiling units.

This survey included stores in which there was an employer and two or more clerks. Regarding the show window intensities above stated, these do not refer to the actual intensity maintained in the window but to the fact that the windows were wired and equipped to attain those intensities; it being practically impossible to determine the average intensity maintained in a window over a given period due to burnouts, lamp removals and dirty equipment.

The true significance of these figures and the vast market which they reveal can best be indicated by quoting from another survey, as follows: Of one thousand stores investigated 991 were in need of better interior illumination and 882 better window lighting. It was further brought to light that of these merchants whose stores were poorly lighted 90 per cent were desirous of securing better illumination as soon as the defects of their present systems had been clearly pointed out. The estimates of the lighting men making this survey as to the cost of bringing the various installations up to a desirable standard show a potential business to the manufacturers, jobbers and contractors of $125,000 in the 1,000 stores surveyed. This survey was conducted in one city alone; conservatively estimating that there are 25,000 stores on the Pacific Coast similarly in need of such improvements in illumination, a market of three and a quarter million dollars is thus opened up. This has to do exclusively with the bringing of old stores up to desirable standards and does not take into consideration the constant market maintained by newly constructed stores.

Recommended Standards.

When we find stores and office buildings which are obliged to change their lighting equipment within a year or so after construction—and in some instances actually before the tenants have all moved in—it is due time for concerted action, on the part of those interested in the welfare of the lighting industry, toward the correction of such conditions. Unfortunately there are today cases where such conditions obtain.

In determining upon the standards which it shall recommend the committee concluded to base these standards upon wattage per outlet necessary to provide the desired intensity and to specify an ample capacity to take care of such increased intensity as the natural progress of illumination may call for during a reasonable period of time. Two reasons governed this decision: First, there is seldom any means of determining at the time of construction what type of store will occupy a building; second, there is no means of controlling, other than by a long educational process, the tendency to reduce the size of lamps occupying the sockets, in an effort to reduce power bills.

By providing adequate capacity at each outlet for the maximum intensity desired, any occupant, regardless of the type of establishment, can have good illumination; and if the wiring is in to take care of increases it is far easier to sell better illumination than if such improvements entail re-wiring.

The recommendations of this committee are, therefore, that store interiors, office and loft buildings shall be wired for three watts per square foot to provide a general illumination of approximately 15 foot-candles. This standard is set as a desirable average toward the maintaining of which the entire industry is earnestly requested to lend its support. Show windows shall be so wired that there shall be adequate capacity to provide for 150-watt outlets on 12-inch centers, together with 200-watt outlets on 10-foot centers for special lighting. These outlets to be in addition to, and on a separate circuit from, convenience outlets for use of art lamps and movable electrical displays.

Means of Broadcasting Standards

The lighting salesman working in the commercial field has two important factors with which he must contend—the owner of the building and the contractor doing the wiring. To the first he must sell the idea of increased lessee-satisfaction and elimination of expensive re-wiring in a few years as illumination standards progress. The second must be imbued with the idea of the increased remuneration resulting from higher standards of work, and the increased good will resulting from such an installation. With the one it is a question of salesmanship—with the other education.

The following means are those which this committee believes can be most effectively employed to properly spread the story of better commercial illumination, toward the end that the great market previously pointed to may be invaded and capitalized upon:

Inasmuch as the terms "poor lighting," "good lighting," and "excellent lighting" as used in many of the present tables of recommended standards have a tendency to cause the average store-owners to be satisfied with a "good" intensity rather than striving to attain the benefits of an excellent job the Lighting Bureau should recommend to manufacturers and others publishing standards that they change their recommendations to specify a capacity per outlet necessary to give the highest intensity which they recommend for each type of store.

The recommended standards of all lighting committees, (residence, industrial and commercial) should be prepared in a printed form for distribution to architects and builders by the representatives of the California Electrical Cooperative Campaign; and should be printed in the Pacific Coast Data and Sales Book, the recognized source of information of electrical contractors.

A most rapid and impressive means of calling the attention of the merchant to the advertising value and sales effect of good illumination would be for the power companies to equip the windows of their offices for a high intensity of white lighting and for colored lighting, spot lighting and flood lighting. These windows could then be offered to local dealers for display purposes, the dealer arranging the window trim of his products and the power company lighting it to secure the most appealing effects. Sales would undoubtedly result for the dealer and he would readily appreciate that if proper illumination could sell his merchandise when it was displayed in the company window, proper illumination in his own windows could most certainly increase his sales. Interest could be developed to a considerable extent in such an effort by advising the local Chamber of Commerce of the plans and pointing out their effectiveness in keeping purchases in the home town and increasing the local merchants' business. In connection with such a program a contest might be inaugurated, a prize being offered to the merchant who trimmed the power company window with the display which was voted by the local townspeople to be the most attractive. In the interest of local development the newspapers would undoubtedly give extensive publicity to such a contest and even carry in their columns the ballots for voting. This plan would, of course, be most effective in the smaller communities.

In closing, this committee goes on record as opposing and condemning sharp practices, unethical methods, and misrepresentations in the sale of lighting equipment; and as recommending the use of standard units of recognized quality only for all installations.

Advertising Value of Electric Signs and Billboards

By TRACY SIMPSON*

THE electric sign as a dignified and valuable medium of advertising is becoming fully recognized. Its popularity and increased use by large national advertisers, including many of the important industries, augurs well for continued and ever increasing business in this important field. Electric signs and illuminated night displays are a mark of progressiveness, and streets well provided with them always indicate commercial activity and life. To the merchant and business man on the street, it acts as a spur and stimulus to the further use of electricity, especially in the form of higher standards of illumination in both store windows and building interiors.

Very few people are aware of the effectiveness of the electric sign as an advertising medium. Some idea of its economy may be gained by glancing at the following comparison of the best known methods.

NUMBER PERSONS REACHED

Adv. Medium	Small Town	Medium City	Large City	Average Cost
Electric Sign	1,000 per day	15,000 per day	300,000 per day	$ 2.00* per day
Newspaper	1,200 per day	25,000 per day	150,000 per day	$11.00 per day
Painted billboard	500 per day	5,000 per day	250,000 per day	$16.50 per day
Street cars	.....	15,000 per day	500,000 per day	$33.00 per day

*Cost of Investment in Sign prorated with operation costs.

It will be noted that while street railways exceed in the number of people reached the cost to the average merchant is prohibitive. Also, the papers, billboards and street car cards are in force only for the month or until expiration of the contract, while the electric sign continues to give its message year after year at a nominal upkeep cost.

Visibility.

There are many types of electric signs in use today which may be classified, as follows:

(1) Channel or display
(2) Embossed letter
(3) Panel
(4) Attraction or interchangeable
(5) Flashing or action
(6) Opal glass letter (drum type)
(7) Illuminated billboard
(8) Indoor and immature

All of these signs are devised to illuminate letters, trade marks or other reading matter so that it will be visible at the greatest distance both day and night. To do this successfully there are certain principles of optics that must be considered, but which are often overlooked.

It has been scientifically determined that the eye can distinguish separate objects if they are so spaced that the angle between them at the point of vision is greater than 1 min. (1/60 deg.). Therefore all parts of the letters and words must be separated by a distance which subtends an angle of at least 1 min. at the distance at which people will read the sign. Otherwise the words and letters will appear run together and blurred. This is only the absolute minimum, however, and it has been found that the distance between members should be from 60 to 75 per cent of the letter height for good results.

The following table gives basic proportions:

Height In.	Length In.	Width In.	Space In.
12	9	3	4
24	18	4	5½
30	22½	5	7
36	27	5½	9
42	31½	6	11
48	36	8	12
60	45	10	15
72	54	11	18
84	63	13	20
96	72	15	21
108	81	18	24
120	90	20	27
144	108	24	30

The proportions of the letters themselves affect the readability of the sign and it has been found that the letters should have a length (horizontal distance) equal to two-thirds or three-quarters of the height (vertical distance).

Thus it is readily seen that the height of the letter has considerable bearing on its readability because in the letters the integral parts are farther apart and thus easier to read at great distance.

The stroke width also has considerable bearing on the sign because of the seemingly contradictory day and night effect. In daylight the wider the stroke the greater the distance of readability, while at night the narrowest stroke gives the greatest readability. Thus it must be determined whether the sign is to have greatest day or night value to determine the stroke width. For general conditions, however, the stroke should be from 20 to 25 per cent of the height. It may be desirable to combine great stroke width in daytime with narrow illuminated stroke at night and thus secure greatest visibility of both day and night.

It is often necessary to depart from theoretical dimensions, however, to give proper appearance to the sign. The designer of illuminated signs must consider all conditions under which the sign is to be used and then decide on the dimensions best suited to the particular case at hand. There is a tendency to follow the path of least resistance and utilize signs of any variety just because it has been done elsewhere, but this practice should be discouraged by the entire industry.

Illuminated Signs and Billboards

One phase of sign lighting which has been developed to a large extent in California is the illuminated billboard. On account of the favorable weather conditions and the many miles of highways close to power lines, illuminated billboards and painted signs have found almost unlimited use.

Though a large percentage of the billboards in the hands of bulletin advertising companies today is illuminated, there are thousands upon thousands of painted signs of all sizes and descriptions, which could be effectively lighted. Many of these signs, painted and repainted at considerable expense, are positively dead at night and their effectiveness questionable by day because of the distraction of daylight activity and confusion. No end of these, therefore, stand ready to be lighted and await only the submission of a plan to the owner by a competent solicitor.

As against the electric sign, the illuminated painted sign offers greater possibility for detail, and the ability to change the design at small expense adds greatly to its advertising flexibility. Since the effectiveness and attractive power of an illuminated bulletin board or sign are largely dependent upon the contrast in intensity with the surroundings, it follows that signs located in brightly lighted downtown districts must be lighted to higher intensities than those in outlying districts. By the same token, the equipment used to direct this illumination on the sign must confine the light to the sign itself, avoiding as much as possible undue spill on surroundings.

Though some lighting of large painted signs has been done by projectors mounted on adjacent buildings, the best results are obtained by the use of specially built, porcelain enameled, steel, angle reflectors mounted well out in front and above the board. Reflected glare from the board and non-uniformity of illumination are common abuses and should be guarded against in the choice and installation of reflector equipment. Angle reflectors, of a design which permits of mounting well above the board, tend to eliminate this objectionable glare or spotty effect and, at the same time, allow a full and unobstructed view of the face of the board

*Sub-Committee on Sign Lighting: Tracy Simpson, chairman; Paul D. House, vice-chairman; H. K. Griffin, H. H. Allison, S. H. Anderson.

or sign. Though the levels of illumination for billboards and painted signs, like that in other fields, are gradually rising, a value no less than 10 ft.-candles on the vertical surface of the sign might be given as good practice in the more brightly lighted districts. Specifications are readily available covering the illumination of various heights of boards.

The following table, however, gives the proper mountings for standard size boards:

Mounting Dimensions of Lighting Units

Height of Board in Ft.	Spacing in Ft.	Distance Out in Ft.	Distance Above in Ft.	Size of Lamp	Ave. Ill. Foot-Candles
2- 4	5	3	1	75 watts	9
5- 6	6	4	1	100 watts	9
7- 8	6′6″	4′6″	1	150 watts	9
9-12	8′0″	5′6″	1	200 watts	10
13-16	10′0″	6′6″	1	300 watts	11
17-21	13′0″	9′	2	500 watts	10
22-25	17	12′	2	750 watts	11
26-30	20	15	2	1000 watts	10

The increased speed of vision obtained through use of higher intensities—a fact brought out in the increased production in factories where better lighting is provided—may well be applied to illuminated billboards and painted signs. The importance of this fact is at once evident when it is considered that the largest percentage of individual observations of these illuminated displays are now made from rapidly passing automobiles and not by pedestrians. It is essential, therefore, that the printed or painted matter be visible at the maximum possible distance to the approaching motorist.

Manufacturers

It would seem that a standardization of ordinances would do considerable toward aiding the sign manufacturer on the Coast, as there is a multitude of sign laws which differ radically for different cities. These ordinances vary from a 12 in. projection allowed at Long Beach, Calif., on vertical signs, to the 4 ft. vertical projection allowed in most other cities, with 18 in., 24, 30, 36 and 42 in. projections sandwiched in between.

Although the Eastern cities are not all standardized the great majority allow vertical projection of 4 ft. and the horizontal projection to the curb, but there has developed on the Pacific Coast a custom requiring all such signs to be swung back against the building during the daylight hours which has retarded development to a certain extent. If the horizontal projection in the various cities could be standardized at 4 ft. a very satisfactory condition to manufacturer, dealer and central station would be attained.

The manufacture of electrical signs can be put on a satisfactory basis only when all manufacturers carry on their product the label of the National Board of Fire Underwriters. Local city ordinances everywhere should recognize this label as covering factory inspection and the manufacture of electrical signs.

Review of the rules of the National Board of Fire Underwriters shows that they are not only reasonable but fairly liberal and any manufacturer who cannot comply with them is certainly not putting out a creditable product. The Board's service on the Pacific Coast has been improved in the past year and the securing of labels and inspection from the Board's representatives works very little inconvenience to the manufacturer.

Lamps

The size, type and kind of lamps for various signs is a subject too large for a complete discussion here but a few important points should be noted.

In the matter of selecting lamps for signs, as in the design of letters, a number of variable factors must be considered. A huge roof sign high up on a skyscraper must have such brilliance that the sign stands out in contrast to the background. The advertiser desires to bring to the attention of the passerby a certain article with such brilliance that the idea is impressed on his mind. Such a sign must have no subdued light as is obtained by lamps equipped with some form of diffusing medium, like frosting or enameling, but rather should have a glittering brilliance, almost a glare, as obtained from a clear lamp.

While within working limits the readability of a sign decreases as the brilliance of the lamp increases, it should be remembered that signs attract by their brilliancy and the advertising value in many cases would not be lessened to improve readability.

For huge roof signs this factor may be neglected as at all times the distance between the sign and the observer is such that the brilliance is not objectionable. In present practice, the signs in large cities are of such high brilliance that additional ones, unless they are at least of equal brilliancy with the surrounding signs, will not attract attention and their value as advertising mediums is lost. However, the smaller signs on the front of buildings and hanging close to the street must necessarily be of a much lower order of brilliancy; otherwise the observer will be blinded by the flood of light and the sign will be illegible, thus defeating its purpose. If, because of high general illumination, it is necessary to have the small, low hanging sign illuminated to a high intensity, some form of diffusing medium must be employed on the lamps in order to prevent the blinding of the observer by the high intrinsic brilliancy of the lamp filament. By using frosted lamps the appearance of signs hanging close to the street is greatly improved, especially to observers at a short distance from them, although the readability at a distance is not greatly changed.

For the small signs with which a trough letter would be used the problem is different. Here the sign is much closer to the observer, and high wattage lamps in clear bulbs would blind a person to such an extent that they would be objectionable. A more diffused or softened light is desirable and low wattage lamps which have been either enameled or dipped in various colors improve the appearance of the sign and attract the eye of the observer by the unique color combination of light.

The most effective means of advertising is the electric sign properly designed and lighted. Yet how many sign owners realize this effectiveness after they have installed one? Burnt out lamps are not replaced for days and sometimes weeks at a time. Also, they are allowed to become weatherbeaten and faded, when at a small cost they can be taken down and renovated.

An electric sign to function properly as a publicity medium should be the outstanding center of brightness in that locality and clearly readable at a good distance. This is proved by the theatres that keep their signs and marquises serviced by some reputable sign manufacturer, who for a small cost will undertake the upkeep and maintenance, that is, keep flashers running properly and replace burnt out lamps. One has but to walk down any main street and make the comparison of sign lighting of theatres and that of other business places to be convinced of the volume of business not receiving proper care. The prospective lamp renewal alone runs into a surprising figure. With the tendency to use lamps of larger wattage and more colored effects this potential business will be greatly increased.

Upon the sale of a sign the purchaser should be sold the idea that outside of an advertising medium a sign should be an attractive decoration for the exterior of his building, and as the operating expense is so low in comparison with the advertising value that he could well afford to have his sign maintained at a small cost. This, the manufacturer could do at a profit by getting volume enough, and the practice would tend to keep him in touch with the purchaser.

Ways and Means of Promoting Sign Sales

Probably the greatest hindrance to sign sales today is the objection on the part of building owners to having unsightly signs on the premises. While in some instances this attitude is justified, the sign industry may readily overcome this by cooperation with those who design the building.

Architects in many instances have become aware of the necessity of the electric sign and are including a sketch of the sign in their building plans, in the same way that they now include the marquise in the design

of motion picture theatres. This is having a tendency to promote sign-lighting by reason of its being drawn into the architectural design of the building.

Signs are constantly becoming more and more elaborate and the old unsightly type of former years has given way to works of art. Individuality in his electric sign is as important to the owner as is individuality in his business and in his other forms of advertising. Especially is it necessary where there are other signs in close proximity. Any marked similarity tends to detract and lessens the effectiveness of all. Distinction in design, color and flashing schemes is highly essential in order to retain full value in attractive power. The particular needs of the customer, therefore, should be carefully considered in the planning of his sign.

Large signs, if properly designed, do not appear to be heavy or bulky. More often, they add to the attractiveness if they are properly designed. The bulky, unfinished appearance of small signs can be largely overcome by a more careful use of ornamentation. Also there is a great demand for a more flexible construction of large signs to permit a change of display. In many districts where the same people pass a sign day after day and week after week much of its effectiveness is lost just because it becomes a part of the familiar skyline. This feature is being recognized by the advertiser who uses the electrical sign medium.

Background, brightness, and border lighting are phases of sign-lighting which are being studied by designers and architects because of their importance. Color, motion, etc. likewise are very important elements and are receiving the attention of the electrical advertiser.

A great many opportunities for sign installations may be gained through intimate cooperation with the power company representatives who are constantly in touch with new consumers. During 1923 one Western power company carried out a cooperative sign campaign with the manufacturer resulting in the sale of 780 signs and adding over $25,000 yearly revenue to the lines. This shows what may be accomplished by cooperation within the industry.

Briefly, the outstanding items for increasing sign sales may be summed up as follows:

1—Standardization of ordinances.
2—Proper maintenance and upkeep service.
3—Architectural designs for buildings.
4—Use of colored and changeable signs.
5—Cooperation with power companies.

Conclusion and Recommendations

The sign committee has realized from the scope of its investigations this year that the greatest work is yet to be done by the sign committees of the Pacific Coast Electrical Association. This committee has not found it possible to go into the matter of laws governing visibility of signs and yet is so fully aware of the need of investigating this phase of the subject that it wishes to urge following sign committees to take up the matter. No greater task could be performed for the sign industry on the Pacific Coast than that of making a close study of sign design and tabulating the effects of spacings, colors and brightness.

Although some very valuable information is already in existence on that subject it is not presented to the industry in a complete and simple form. This committee, therefore, strongly urges the sign committee of 1924 to investigate and make a complete report of laws governing visibility of electric signs.

Activities of the Consumers' Service Bureau

By A. M. FROST*

THERE has developed a strong realization, by the men engaged in the commercial departments of the electrical industry, and particularly the central station industry, that the foundation of business development must be laid with a proper appreciation of the obligation the industry owes to its customers and consumers.

The basis of all sales and general business promotion, is, first of all, satisfied consumers. The value of a satisfied consumer as a salesman is not to be over-estimated. There has been much good work done by the different central station companies to promote a better understanding between the consumers and the utility companies, and it is desired by the members of the Pacific Coast Electrical Association, that these different company executives, in the commercial departments, be able to avail themselves of the experience and knowledge that has been individually developed.

With the above general ideas in mind, it was decided at the organization meeting of the Commercial Committee, held in Los Angeles on Aug. 10, 1923, to organize the Consumers Service Bureau and a committee was appointed to carry on the work of the committee.

Considerable valuable discussion took place at the Los Angeles meeting and it was proposed that the membership of the Consumers Service Bureau meet frequently for general discussion of the activities engaged in by each of the central stations represented. It was thought that these meetings would be beneficial, in that the knowledge of the work of the different companies represented, might be passed on to the other companies. It was also thought that a general discussion along these lines would develop new ideas that could be used by the entire membership, to good advantage—the ideas so developed being passed on at the meetings as to their desirability for general use, and after definite activities had been decided on, specific ideas could be taken home by the members and laid before the general executives of the central station companies for their consideration and adoption.

The discussion brought out that all of the central stations were attacking this problem from various angles—some sending out questionnaires to their customers, soliciting suggestions, or complaints, while others were doing the work through a house to house canvass. Other companies were soliciting the co-operation of their entire organization by providing all their employees with blanks, or booklets, on which they could turn in to the proper department, consumers' complaints, prospects for new business and personal suggestions for the betterment of service. In this latter activity, it was found that some of the companies were holding employee meetings for the purpose of explaining to their entire organization the vital necessity of rendering proper service to their consumers and gaining their friendship, and getting from them prospects for additional business.

It was thought that the operating organizations, particularly the linemen, line-foremen, service men, meter readers and other employees engaged in like activities, could be of definite benefit to the central stations and could materially aid in building the electrical industry generally, if they could be impressed with the proper appreciation of their ability to do this work. It has been found very desirable, where such interest has been developed, to report back to the employee turning in such information, on the action that has been taken on the information he supplied. This reporting back to the employee definitely informs him that his work is appreciated and of benefit to his company and tends to maintain his interest and to perpetuate it.

It has also been found that if the contract wiremen and representatives of other allied electrical industries, are provided with suitable stationery on which to make these reports, they will co-operate, and a much better understanding between these allied industries and central station employees can be developed.

The development of this thought led to the appointment on the Consumers Service Bureau, of men representing manufacturers, contractors and dealers, and other organizations whose opinions and experience would be valuable to the central stations, and valuable to the electrical industry as a whole, in promoting business and good feeling. It was felt that the California

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Electrical Co-Operative Campaign should be represented on this committee, on account of their close affiliation with both the central station and the allied industries.

The first regular meeting of the Consumers Service Bureau was held in Fresno on Oct. 19, 1923. At the opening of this meeting, the chairman read the following paragraph written by Don C. Ray, and taken from his article appearing in the Oct. 1, 1923, issue of the Journal of Electricity.

> "At no time in the history of the public service companies, has the item of good will weighed so heavily or received so much attention. It has come to be the major factor in the consideration of executives and all plans for utility development give it serious thought. With the public good will, all things are possible, but without that good will, ultimate destruction looms. This has been written boldly in the pages of the public service history and these pages have marked the passing of the old-time arbitrary 'public-be-damned' official."

With the reading of this paragraph as an inspiration to the members present, the meeting was thrown open for discussion, and many valuable suggestions were made by the members present.

The value of eliminating as much red tape as possible in our dealings with consumers was discussed. The rendering of prompt service to new consumers, by accepting their applications over the telephone and having their applications and other necessary papers delivered to them, by a service man, for signature, rather than requiring them to come to the office, was discussed. It was found that many of the companies represented were handling their service orders in this way and that much favorable comment, by consumers, had resulted.

The importance of securing thoroughly competent help to handle service work, was brought out. It seemed to be the general opinion of all members present, that the companies should very carefully select service men —particular attention being given to their appearance, personality and general fitness to deal with the public. It was pointed out that any man of proper personality, irrespective of previous electrical training, could be taught the routine work necessary to its accomplishment, but that it was a particularly difficult thing to take a man of improper personality, even though he be skilled in electrical matters, and reconstruct his personality so that he would be acceptable to the public as a representative of the utility.

The subjects of instruction and education of employees dealing with the public, were discussed and the different members present told of what their companies were doing. Some companies are handling their educational work through their employees' associations and clubs, where others are attacking it as a purely educational program, conducting schools for employees in the various departments of the company. The necessity of arousing interest on the part of the employee and pointing out to him the big advantage that he, personally, will derive by selling himself to the consumers, was discussed at some length. If an employee of proper personality is selected, there will be no difficulty in bringing about this very desirable situation.

The subjects of collections—the desirability of simplifying rates and bill forms, and the desirability of making prompt adjustments in case of error, with a full explanation to the consumer of how the error happened to be made, were discussed at some length, and several valuable, definite, suggestions were made. It was quite evident that these suggestions registered with the members present, and it is certain that many slight changes in dealing with our consumers have been brough about by the different companies, as a consequence of that meeting.

Improvement in service and a friendly contact with the consumer will do more to produce a sympathetic feeling on the part of the consumer than anything else. Company executives should frequently approach their company with the view of the consumer—putting themselves in the place of the consumer and with an open mind following through the company's requirements to obtain service, and criticizing those requirements from the standpoint of the consumer uninformed on company routine matters, rather than attempting to analyze their points from the standpoint of the man informed on the detail of conducting a utility business. Consumers must be dealt with as individuals, rather than as a group, and their individual criticisms should be considered.

A committee was appointed to obtain from all of the utility companies of the state, samples of the forms used in direct dealing with the consumers, such as cut-in, cut-out, complaint, bill, and inspection forms, as well as bill notices and notices for shut-off in case of non-payment—these forms to be studied at a future meeting, with the idea of arriving at a uniformity throughout the state, picking out the forms most desirable for accomplishing the purpose and the least offensive to the consumer.

Other activities discussed by the members present, and engaged in by the utilities of California for the betterment of relations with consumers, were:

1. Sale of company securities to the public.
2. Mailing of questionnaires asking for service criticisms.
3. House to house canvass for the purpose of receiving criticisms and making adjustments of disputed accounts, as well as the repairing of idle lamp socket devices, without expense to the consumer.
4. The attending of civic meetings and service clubs, by company representatives.
5. The attending of Farm Bureau meetings.
6. The use of moving pictures at public gatherings, for the information of consumers, on utility matters.
7. The survey of consumers' installations, both industrial and agricultural, for the purpose of informing the consumer on the use of his apparatus, as well as making efficiency tests on equipment installed, to promote a more efficient use of utility service and to promote a feeling of confidence on the part of the consumer.

The use of the word "complaint" in designating a department of printed form, was discussed, and it seemed to be the unanimous opinion of all members present that the use of the word should be eliminated. Consequently, a committee of one was appointed to investigate the psychological effect on consumers of the word "complaint," and to make recommendations at the next meeting for some other term that seemed fittingly to take its place. It is thought that a great many consumers come to us with the idea of making constructive criticism, but that they hesitate to approach the window labeled "Complaint Department," as they do not wish to see their name attached to a form carrying the designation "Complaint Tag."

The word "complaint," carries the wrong impression. It makes the consumer feel that we are looking upon him as a complainant and that he is of considerable nuisance to us. It also creates the impression that our service is rather poor, or we would not find it necessary to open up a department for the purpose of handling our numerous complaints.

The second meeting of the Consumers Service Bureau was held in Del Monte, on Jan. 25 and 26, 1924.

Discussion of the Courteous Service Club of the electrical industry, being promoted by R. A. Balzari, was entered into, and it was the opinion of all the members present, that this very definite and tangible piece of work accomplished considerable good.

The service rendered by the Standard Oil Company, the securing of their high-grade employees and their general policy toward customers, was discussed and it was thought that the electrical industry could learn considerable from studying their methods.

It was the consensus of opinion that the utility companies should make, free of charge, minor repairs to all varieties of appliances, only charging for necessary replacement parts. This work can be accomplished by trouble men carefully following up fuse troubles to determine what caused the fuse to blow, and in that way, frequently definitely locating the trouble in some particular appliance that might cause the second blowing of a fuse when put into use the second time. If not repaired, this appliance would probably be discarded, with consequent loss of revenue to the Company and the loss of service to the consumer. The careful selection of employees for this class of work was also discussed, at some length.

The committee appointed at the Fresno meeting, to find a proper substitute for the word "complaint," reported with the following suggestions offered:

Adjustment Department.
Consumers Service Department.
Correction Department.
Service Bureau.
Emergency Department.
Welfare Department.

The suggestion of a name applicable to the department to adjust complaints and offer suggestions for better service, was considered a very timely one.

One of the members present reported that his company had adopted the term "Investigation Department." Another member present reported that his company favored the term "Consumers Service Bureau."

It was the thought of the chairman that the work of the Consumers' Service Bureau is not complete, and that completion of its duties cannot be expected within the term of a year. Benefits have been derived from the discussion that has taken place at the different meetings, and it is earnestly recommended that the work of this committee be continued, next year, with the further recommendation that the Public Relations Committee have, in its membership, men fully conversant with the problems of consumers' service. A close tie-in between the Public Relations Committee and the Commercial Committee of the Association, should accomplish the results that the Consumers Service Bureau is trying for, without the necessity of possible duplication of effort, for it is recognized that the Public Relations Committee's work and the work engaged in by the Consumers' Service Bureau, very closely parallel each other.

Report of the Safety Rules Bureau

By R. H. CATES*

THE major portion of the work of the Safety Rules Committee of the Pacific Coast Electrical Association was completed during the two years prior to 1923 when the members of that committee spent considerable time and effort in aiding the different branches of the electrical industry and the Industrial Accident Commission of the State of California in formulating a set of rules that would outline the proper methods of installing electric wiring and apparatus to afford the greatest possible amount of protection to life and property within the state. During this period tentative rules were published by the Industrial Accident Commission and after applying these rules throughout the state to determine if any radical defects were apparent a revised draft in type-written form was practically completed just prior to 1923. At this time the state budget was being revised with the result that insufficient funds were provided to complete the type-written revision of the rules in such form as to be again printed before bringing them up for a public hearing.

The Industrial Accident Commission has been working on the revised draft with a limited force throughout the year of 1923 and at this time, March 21, 1924, we are pleased to report that sufficient funds seem to be available to enable the commission to get the revised rules to the state printing department in time to bring the matter to a public hearing and have the rules printed in their final form by July of this year. During the past year the Safety Rules Committee has held one meeting at San Francisco and one at Los Angeles, but beyond discussing the rules briefly and instructing the chairman to keep in touch with the Industrial Accident Commission with the idea of assisting its electrical engineer in any way possible to get the revised rules in the hands of the state printing department, there has been very little opportunity to accomplish any real work of a constructive nature.

During the meetings held this year matters of a general nature have been discussed along the lines outlined in the proposed safety rules to a considerable length and it has seemed to be the opinion of those present that the work of the Safety Rules Committee should not be abandoned by the association until such time as it is demonstrated that the rules, when put in practice, represent the best possible practices along the lines of properly protecting the industry and the public in general against hazards to life and property.

It is to be regretted that the state has had insufficient funds to carry this work to completion at an earlier date but this condition is expected to be relieved soon.

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Utility Accounting

By A. B. CARPENTER*

INASMUCH as new classifications of accounts have just in the last year been adopted, there does not appear to be any reason or necessity for changes in the present general structure. From the report and from our contact with the national body, it seems that the efforts have largely been directed toward the introduction of the national classification to the various states. There is, however, a growing necessity locally, and seemingly otherwise, for a uniform interpretation of classifications.

It is, of course, well known that a text to anything is very general and is intended to fundamentally establish a basis for the finer distribution of items with the same characteristics and for the same purposes. This is sound in principle, and if it were not for the fact that most electrical utilities cover a wide area of distribution, consequently making it necessary for a large number of people to use their own interpretation, satisfactory results might be expected. The importance of this question first becomes individual, that is, any utility which is operating over a wide area of territory will find as wide variations in its interpretations as with one company compared with another.

It is then obvious that if this is not very carefully guarded the utilities accounting will become badly confused and represent only a small degree of accuracy. It is also very important to the industry as a whole. We are fortunate indeed in having long since passed the time when it was thought necessary to keep the facts of our business hidden from others. For it is only by comparison that we can find the measure of our own efficiency.

It again becomes obvious that without a very clear understanding and an agreed upon uniformity between companies, the comparative results would be very unsatisfactory. Therefore this committee has made it an important part of its work to carry on this study with the view of producing in as fine detail as possible a uniform interpretation of the present classification of accounts, and, while it is a big task and will require more time than the present committee has to finish the work, it is felt that such benefits will accrue to the member companies as to warrant the succeeding committee being specifically charged with the duty of its completion.

Fixed Capital Records

Member companies and particularly those in California are keeping their fixed capital records in practical uniformity and in harmony with the classification of accounts. There has arisen no new matter nationally or locally from which there came any beneficial suggestion.

Budget Arrangement

While this is a well recognized and adopted method by which to regulate internal financial affairs, investigations locally have shown the budget to be peculiar to the individual utility. We have not been informed by the national body of successful efforts to produce uniformity in budget application.

Preservation of Records

There appears to have been very little activity, either nationally or locally on this subject. This is doubtless due to the fact that it is very largely a matter which is again peculiar to the individual company.

Pay Roll Standardization

This is another subject which has offered very little material for discussion and seemingly is so with the

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national body, as there have been no suggestions from its committee.

Customers' Records and Billing

This subject for the most part has been confined to the more important aspects of comparative values of machine methods and handwork. It has received perhaps as much attention as any phase of the industry. There have been for observation very large installations of machine equipment, and from that all the way down to the one man office. There are combination installations, or systems of machine and hand methods. Some of these systems have actually gone so far as to eliminate book records. There have been extensive experiments and exhaustive investigations out of which comes an amazing amount of confusing statistical data.

Some of the large eastern companies are carrying two or three plans in trying to find the way. The unit cost of production has been found to be as variable as the differences of opinion and results of all experiments, from which there can be no definite conclusion drawn as to the distinct advantages of one method over the other. It will be found, however, that while there have been a few machine installations discarded altogether, the research work is directed more or less toward the improvement of the machine method. This would seem to show the tendency in the belief that it will ultimately be distinctively advantageous.

The machine manufacturers of course have kept pace with the progress and in collaboration with the industry some of them have recently produced machines with seemingly a great deal more capacity. Some of the companies are now installing this new type of equipment from which it is hoped and really expected more definite results will be shown than have seemingly been possible with the older type of equipment. Out of all of this, however, the committee comes to the brief conclusion that production cost should be the basis for prime consideration; that generally speaking the confusion in the available data has been brought about through the lack of uniformity in the classification of items of cost; that consumers' billing by machine methods can be recommended as being superior in many respects, including to some extent production cost; that consumers' bookkeeping by machine method has very little, if any, advantage over the hand method. (This refers to the older type of apparatus generally in use at present.)

The introduction of machine methods into the general work of the office has been done with more satisfaction than that of the consumers' department. For instance, where a company has a large volume of calculations and the work can be concentrated into the hands of a few machine operators, a very much higher production will be turned out, and consequently at a very much lower unit cost, which also relieves the more expensive help as a rule to carry on the more important duties.

There are some phases of general bookkeeping which can be very conveniently and satisfactorily adapted to machine methods. For instance, cash book work can be arranged so that the daily cash statement, bank register and cash book, and the distribution of the disbursements can be written in one operation. In journalizing, the check, voucher and journal sheet, and the necessary distribution can be written out at one operation. In those installations with which the committee is familiar the output is just as great, and there is the satisfaction of knowing that as the work progresses everything is automatically footed and balanced. This class of work is usually intrusted to expensive help, but under the machine method it can safely be turned over to the less expensive.

For companies having a sufficiently large number of stockholders an addressograph installation will be found very satisfactory. For full period dividend payment there can be written at one operation stockholder's name, address, bank or trustee, to whom payment should be sent (if this should be the case), also number of shares of stock, date, number of checks, bank from which payment is drawn, and such other information as might be necessary. For those that have not such an installation, and where volume justifies, this method can be very highly recommended both from the standpoint of convenience and expense.

The transportation division of the Stores and Purchasing Committee submitted to the Accounting Committee a form which is designed to bring about uniformity in the classification of automobile expense. It was thought best that the two committees should reach an agreement, which, with a few minor suggestions, has been done. It is felt that where it is possible for the individual companies to use it, a great deal of benefit can be derived from comparative cost, and therefore its adoption is recommended. The form itself will no doubt be submitted in the report of the Stores and Purchasing Committee.

County Franchise Tax

A recent decision of the Supreme Court of the State of California entitled "County of Tulare against San Joaquin Light & Power Corporation" purports to interpret that portion of paragraph 3 of the so-called Broughton Act, under which of late years franchises to occupy the public streets by utilities have been granted, and the essence of which paragraph is that "during the life of said franchise the grantee must pay to the county or municipality 2 per cent of its gross annual receipts arising from the use, operation or possession of said franchise," this being effective after the first five years of the date of the franchise. The difficulty has been to ascertain what portion of the gross annual receipts arose from the use, operation or possession of the franchise and a number of seemingly equitable methods were discussed only to be found unsatisfactory to one or more of the counties or municipalities claiming a portion of the gross annual receipts of the same public utility so that to insure a uniform method, to prevent duplicate payments upon the same income and to provide for a division of the receipts amongst respective claimants, as in the case of a municipality carved out of a county subsequent to the granting of the franchise, this suit was brought. The decision of the Supreme Court leaves this method in a somewhat vague light but sets the court's approval upon the validity and workability of the act and suggests to the parties concerned a method, but not necessarily an exclusive one.

Companies not having committed themselves by agreement or previous payments or precedent of any sort or another method, it is thought will find the following plan a very good one and possibly acceptable to the interested counties and municipalities as quite a number have already agreed to it.

	1915 System Mileage		1916 System Mileage	
County	Franchise	Non Franchise	Franchise	Non Franchise
Kern	40.50	375.75	41.75	390.15
Fresno	75.30	435.25	83.30	515.00
San Joaquin	31.25	238.00	34.78	275.23
Stanislaus	25.15	143.25	26.25	153.80
Total,	172.20	1192.25	186.08	1334.18
		172.20		186.08
Total Mileage		1364.45		1520.26

	1915	1916
(a) Percentage which franchise mileage bears to total mileage	12.6210	12.2490
(b) Percentage of total investment represented by pole lines	34.82	30.16
(c) Gross receipts	500,000.00	575,000.00
(d) Amount of gross receipts allocated to pole lines (c × b)	174,100.00	173,420.00
(e) Amount of receipts allocated to franchise mileage (d × a)	21,973.16	21,242.22
(f) System franchise tax (e × 2%)	439.46	424.84
Kern County		
(g) Percentage which county franchise mileage bears to total franchise mileage	23.517	22.436
Amount of tax for year (f × g) distributed as follows:	103.35	95.32

	Mileage	Tax	Mileage	Tax
City of McKittrick	3.25	8.29	3.50	7.99
City of Maricopa	1.15	2.93	1.40	3.20
City of Taft	2.60	6.63	3.00	6.85
County	33.50	85.50	33.85	77.28
	40.50	103.35	41.75	95.32

For purpose of illustration names and figures have been used arbitrarily. It is contemplated in this set up that each county would be entitled to the basis from which its pro rata comes, but of course from there on can be interested only in its share of the tax, therefore each and every county would receive a complete statement changed only in respect to the report or accounting for the particular county tax, as illustrated.

Most of our member companies are, or will be, operating some of their hydro plants and appurtenant facilities as project property under license from the Federal Power Commission. Most everyone is more or less familiar with the Water Power Act, and the rules and regulations established by the Federal Power Commission which govern in the administration of the Act. The most important of these regulations perhaps are those having to do with the recapture clauses of the law and headwater improvement charges, which in the first instance brings about the necessity for the allocation of earnings and operating expenses against the particular project property. There is also involved in this question the matter of ex-appropriations of surplus earnings. In other words, if it is so determined by competent authority that after twenty years of operation there has been an excessive profit from that particular project, the excess would have to be considered as a part of the return of the investment in case of recapture.

In the matter of headwater improvements it is required that where one company operating under federal license has made improvements which are beneficial to another who is also operating under a federal license that there shall be paid a rental charge so to speak in some form or other to the company owning the improvement by the company or person receiving benefits. It can be seen that every member company affected is faced with one of the most intricate problems to work out that can be imagined. There has been a great deal of work done and study given to this question but without any particular progress toward its solution, even in the individual case.

This committee feels, however, that all member companies are entitled to, and probably will need, all the help it can get from the association, and it is with the belief that they will greatly benefit, that a continuance of the study of these subjects by succeeding committees is recommended.

Break-Downs in the Field

By W. H. FAIRBANKS*

THE subject of emergency equipment is divided into two sub-divisions, namely, break-downs in the field, and pool cars and taxicab service. These two problems are discussed separately as the relationship between the two is not very close.

Break-Downs in the Field

The matter of how to handle break-down in the field goes further back into operating practices than the subject itself implies. The actual handling of a break-down in the field is something to be cared for in accordance with the circumstances surrounding each individual break-down and in the most economical manner possible. The initial vital point here is that however the details of the repairs are handled they should be handled under instructions from the transportation department and should not be left to the judgment of the driver or department involved. In other words, the problem should always be put up at once to the transportation department by telephone or otherwise, to see how each break-down should be handled and the department to which the unit is assigned should not be given authority to go ahead and handle break-down in any fashion as best meets their ideas of what should be done.

Before discussing the technic of how to physically handle break-downs a little thought should be given as to the cause of break-downs. In practically all cases other than straight accidents, break-downs in equipment are due to some lack or defect in mechanical maintenance of the vehicle and those defects are usually the result of letting little things go until they develop with a crash into a big thing. This in turn leads to the shop practice problem of day mechanical crews vs. night mechanical crews and there is a clean-cut line of division of thought as to which is the better practice to follow. The two basic ideas of handling mechanical maintenance follow.

Day Crews

Maintain whatever day crew mechanics are necessary for both overhaul and repair purpose, and maintain enough extra equipment to care for emergency calls for break-down service. Do not maintain much, if any, night crew.

Day and Night Crews

Maintain whatever force of day mechanics is necessary to care for overhaul and miscellaneous work and maintain a force of night mechanics heavy enough to clear all trouble which has developed during the day and to tighten up the cars generally. In analyzing the advantages and disadvantages incident to both methods of operation the outstanding disadvantage of the second alternative is the fact that it is impossible to get maximum efficiency out of men working at night and also on account of the heavy labor turn-over. Other than this, the advantages of the second alternative are in its favor as against the first alternative and one great practical advantage which accrues from the second is the fact that it practically eliminates break-downs in the field. The Pacific Telegraph & Telephone Company has been following this latter practice for several years past and a field break-down from anything other than an accident is practically unknown to it.

The consensus of opinion of the members of this committee seems to favor the night shift alternative, but the difficulties attendant to working the night shift seems to deter some of the members from attempting to follow this practice. There is a feeling that from 60 to 70 per cent efficiency is obtained out of night work as compared with day work, but this loss of 40 to 30 per cent in efficiency is far more than compensated for by the freedom from break-downs with its attendant time loss to the people who are using the vehicle.

Shop Tow Car

In physically handling field break-downs the consensus of opinion seems to be that a shop tow car equipped with tools is correct and that on report of break-down this car should be sent out at once with the necessary mechanics to make road side repairs. If the break-down is serious it is, of course, necessary to also send out a relieving vehicle. The necessity for such relieving vehicle can almost always be determined from the first telephone report. It should always be borne in mind that the big unseen factor of cost incident to break-down is the loss of time and demoralization of the people who were using the broken down vehicle and all efforts should be centered on getting these people at work as soon as possible.

Pool Cars and Taxicab Service

It is necessary to give a little thought to the basic principle underlying the furnishing of passenger car automobile service and the underlying principles to be followed are ones to be determined by the management only. In other words, there are certain organizations,—notably a large commercial company,—that furnish their employees with touring cars and roadsters for business purposes, but that also allow these employees to take their cars home and to all practical purposes consider such cars as the employees' private property while off duty. This practice is followed to a greater or lesser extent by some other larger organizations, but the universal consensus of opinion among utility people is that it is a bad practice to follow and that passenger car automobiles should be considered in the same light as any other tool and are to be used for business purposes only. This being so, it is very highly desirable that by far the greater bulk of passenger car equipment be used during working hours only and this equipment should be garaged at night in company garages rather than at the home of the individuals. This being so, it is obvious that a number of marked economies can be effected by having one car serve the needs of as many people as possible instead of assigning the car to the exclusive use of one individual. The present practice of one company is as follows:

The entire list of employees who use passenger cars is carefully scrutinized and studied and a list is made

*Sub-Committee on Break-Down in the Field: W. H. Fairbanks, chairman.

up of those people who need a passenger car all the time. To such people a certain car is exclusively assigned. The basis of this study is the kind of work these people are on, whether or not they are in the field approximately 100 per cent of the time, what amount of traveling is necessary when they are in the field and what other economical means of transportation are available to them such as street cars, stages, etc. In addition to this some very few of the high placed executives are assigned exclusive use of certain passenger cars.

Pool Service

People whose use of automobiles is spasmodic and irregular are not assigned exclusive automobiles, but are instructed to use pool car service. In Los Angeles one company has a pool service consisting of a fleet of approximately sixty passenger cars, these passenger cars being Fords, Chevrolets, Dodges and three Buicks. The three Buicks carry permanent chauffeurs and the balance of the fleet do not. When the need arises for the use of a car by some person to whom a car is not exclusively assigned, this person secures from his supervisor a team order which states the employee's name, where he is going and the approximate length of time the machine will be out. The information on this team order is then telephoned to the garage dispatcher and a specific car is assigned the employee. The employee then presents the team order to the garage attendant at the place where the machine is housed and receives the machine from the attendant. The employee will also sign out on the team order and the garage attendant will time-clock stamp the team order and note on the team order the speedometer reading. When the car is later returned the employee signs off on the team order and the garage attendant time-clock stamps the team order in and notes the speedometer mileage in. By this means there is a complete record of the length of time the employee kept out the car and the actual miles traveled. A study is made day-by day of the results as shown on these team orders and if any unnecessary use has been made of the car the attention of the department involved is called to this fact.

The use of this system has given excellent economical results. There is, of course, more or less friction to overcome and the whole thing has been a campaign of education of employees as to when to use an automobile and when not to use one. Previous to the establishing of this system the company rented a large number of cars from employees and in one instance alone (the three Buicks and drivers) the placing in service of three cars did away with the rental of approximately ten cars. The Buicks in question are used by the higher supervisors and the thought in providing chauffeurs for these cars is that a supervisor should concern himself mentally with the problems of his particular position rather than to be obliged to concentrate on the problems incident to city driving and traffic. Many people personally enjoy automobile driving and as a consequence some of the supervisors do not altogether agree with this theory. At the same time the theory seems sound from almost any angle. The use of these chauffeurs also tends to greatly lessen the improper use of company equipment. The Dodges, Chevrolets and Fords are used by the rest of the employees and the class of car which is assigned to any particular employee is contingent upon the kind of position which such employee holds with the company.

Another excellent result along economical lines obtained from this pool service is in the increased mileage from the individual cars. Nearly everyone is familiar with the high percentage which fixed charges bear to the total operating expense of any car:—these fixed charges in the case of passenger cars running anywhere from 55 to 70 per cent of the gross operating charges. One company is operating some 200 Ford touring cars and roadsters. Of course, many of these cars are assigned exclusively to individuals but, despite this fact, the use of the pool system of touring cars and the elimination of 100 per cent assignments where the mileage did not warrant such assignment has increased the average mileage for the whole Ford fleet from 700 miles per month to 900 miles per month. This, of course, reflects itself in lowered operating costs.

It is of course understood that this pool and taxicab system is of value only in places where there is a large concentration of employees with the attendant large use of passenger cars. This scheme probably would not work in small centers and its use is not as yet attempted in places where only two or three cars are involved. In this connection the general superintendent of the Consolidated Gas Company, of New York City, has just been on a tour of inspection through the West and says that his company has such a scheme in New York City, and that they find it a big money saver for them. They are using a fleet of about 125 Buick "4" touring cars, all carrying chauffeurs.

Maintenance and Operation of Automotive Equipment

By J. M. WAINSCOAT and O. M. SIMPSON*

MAINTENANCE and operation—methods of repairs, shop practices, service systems, including lubrication and washing—being a very broad subject, embracing almost all of the operation of the transportation department from beginning to end, it is thought it could best be served by securing information from the various public utilities as to their practice and the submission of a condensed report of the information thus obtained.

Accordingly, a questionnaire was prepared and sent to a number of the leading public utility companies of the state. Replies were received from the following:

Pacific Gas and Electric Company
Great Western Power Company
Department of Public Service, City of Los Angeles
Southern California Edison Company
Southern California Telephone Company
Los Angeles Gas and Electric Corporation
San Diego Gas and Electric Company
Southern Sierras Power Company
San Joaquin Light and Power Corporation

From a careful analysis of the replies received from these companies it is found that their policies were generally very much different upon any one subject and that it would be impossible to make an intelligent and comprehensive digest of their methods that would be suitable for a committee report.

Inasmuch as this is a very important subject, it is thought a thorough discussion should be given to all these questions in order to enable the committee to formulate a comprehensive and definite report for some future meeting.

The following is a list of the questions and the condensed answers prepared:

I. (a) Equipment coming in for repairs.—Is it inspected by someone to determine whether it is cheaper to repair or sell and replace with new?

Answer:—The policy of most of the companies is to inspect cars brought in for repair to determine whether they should be repaired or replaced.

(b) How does your company determine the life of a car and when it should be replaced with new?

Answer:—The policies of the various companies are widely different on this subject; however, several favor a system of determining the life of a car by its operating cost and condition. It is observed that there is considerable difference as to what would be the right time in the life of a car to dispose of it. For illustration, some of the companies favor using cars for as much as from two to ten years, while others favor a much shorter usage.

Generally, it has been the experience of the San Joaquin Light & Power Corporation that it is far more economical to determine the life of a car by the mileage it has run and what it costs per mile at a given time.

(c) What method is used as to the amount of money to be spent in the repairing of a car when it comes in for repairs?

Answer:—On this question the various companies are pursuing widely different methods, generally having no definite way of determining amount to be expended on cars for repairs.

A preferred method, it would seem, is to judge a car by its relative operating cost to a group of cars of the same class, giving consideration as to topography of the country over which the car operates.

For illustration, assume a group of 100 Fords to average in maintenance cost 4c per mile, up to 20,000 miles. Should a car jump to 8c per mile within the 20,000 miles, it is apparent that it is costing too much to operate and care should be exercised about making expensive repairs on such a car.

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*Sub-Committee on Maintenance and Operation: J. M. Wainscoat, chairman; O. M. Simpson, W. J. Schaefer.

(d) Does your company rebore and completely overhaul motors and chassis?

Answer:—In this question information was sought as to whether the companies followed a policy of reboring and completely overhauling all classes of equipment.

It was found that all were doing this class of work with the exception of the San Joaquin Light & Power Corporation, which does this work on trucks and high priced cars only, and on them in as limited extent as possible.

(e) Does the foreman inspect all cars as they come in for repairs and as they go out completed, or is an inspector or working foreman employed to do this checking?

Answer:—All of the companies inspect cars coming in for repairs as they enter and leave the garages. The foreman does the inspecting.

(f) When a car comes in for repairs, are only those repairs made that are requested by the driver, or is the car checked over and all necessary work done? How is the driver cared for if he cannot wait until his car is finished?

Answer:—All the companies say they do all work necessary each time a car comes into the garage for repairs, instead of doing only what the driver may request.

The question as to what arrangement is made with the driver of a car that goes into the shop for repairs was intended to gather information as to the system of handling swing cars, followed by the various companies; all answers were to the effect that the driver was provided with another car.

(g) How does your company service cars with gas, oil and tire inflation?

Answer:—Practically all companies maintain the system of servicing cars independent of the drivers whenever possible. In outlying districts, the drivers are supposed to look after their own cars.

(h) What check have you to see that all cars are properly oiled and greased, and how do you handle the greasing and oiling of cars?

Answer:—One company sends out cards notifying drivers to oil and grease. Two others use stickers on the face of speedometer showing last speedometer reading or date when the car was greased. Others depend upon their garage foreman and drivers to watch the cars and have regular forms or charts to check this work.

(i) What set-up have you to determine when a car is to be washed?

Answer:—The information sought through this question was as to who had authority to order a car washed and as to who is held responsible for having the car washed.

A number of companies have no well defined system to determine the necessity or time for washing of cars. Others require truck drivers and chauffeurs to watch this detail and perform the work, holding them responsible for the appearance of the cars. Cars without regular drivers are cared for by the shop foreman.

(j) Do you wipe off and clean the windshields on all cars stored in garage at nights?

Answer:—All of the companies except two, wipe off and clean windshields at night on cars stored in garage.

(k) What method do you use as to the painting of cars?

Answer:—Policy varies widely. Some companies have no standards in this regard whatever. They paint when the appearance of the car and convenience for doing the work seem to justify it.

Two companies have standardized on color for repainting of cars.

II. (a) Have you some set-up for handling extraordinary charges against the equipment such as wrecks, burning up of motors, etc.?

Answer:—All of the companies except one, handle charges of this nature the same as any other maintenance expense.

The Pacific Gas and Electric Company charges fires and wrecks to depreciation reserve.

(b) Does your company call for bids from the different dealers when they want to trade in their old cars for new?

Answer:—All of the companies except two, call for bids on cars to be sold.

(c) Do you take any salvage from the old car before putting it up for sale, such as removing the good tires and special company equipment replacing them with old tires and standard car equipment?

Answer:—All accessories that are special company equipment are removed. As to anything else being removed will depend upon whether it is possible to improve the trade by doing so.

Automotive Labor Saving Devices

By P. H. DUCKER*

THIS committee desired to present only such labor saving devices as relate to motor vehicles or allied equipment and this report will cover only those devices which have been perfected and thoroughly tried out by the various utility companies adopting them. It is not the intention at this time to cover the matter thoroughly but to give a few ideas as to what may be accomplished along these lines.

The following labor saving devices, brought up at this time, are the most interesting and desirable. Briefly, they are as follows:

Loading and Unloading Heavy Material.

In loading and unloading five ton trucks the cost of labor in handling material often exceeds the entire cost of the transportation charge but, with the aid of a power take-off on the transmission, attached to the winch on which is coiled a steel line having a gipsy head mounted on the end of the shaft, the methods of loading and unloading heavy weights from trucks is reduced to a minimum. This winch is also adaptable and desirable to the loading of heavy transformers or pieces of machinery on trailers and in buildings.

Care of Small, Light Material, Small Tools, Etc. on Trucks

Most of the utility corporations have difficulties in taking care of small hardware, tools, records, and one of the most serviceable and accessible types of bodies is that shown in one of the accompanying photographs.

Pumping Water from Man-Holes on Underground Systems

During stormy weather, one of the chief difficulties encountered by the electric companies to maintain service is the pumping of man-holes on underground systems. There has been designed a centrifugal pump which is usually attached to the front of an automobile by which the operator is enabled to use the motor of the vehicle in operating the pump to empty the man-holes.

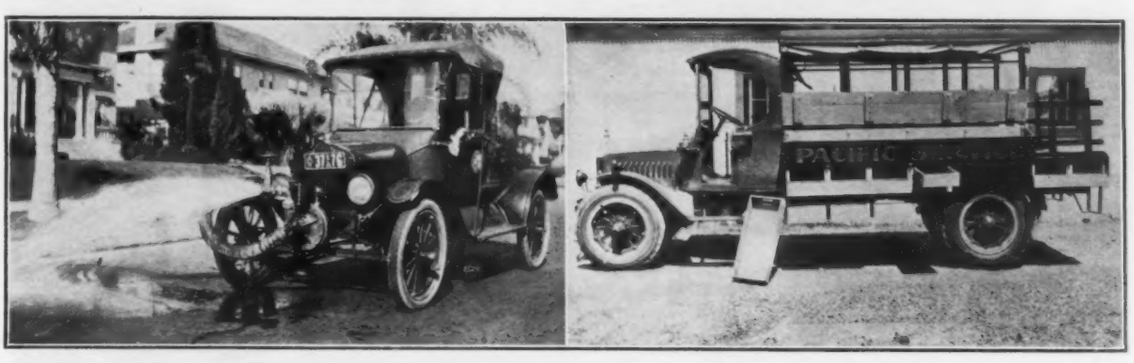
Extra Heavy Duty Trailers

To those companies requiring the use of a ditch digging machine, the accompanying photograph clearly shows a very satisfactory trailer for moving this type of apparatus from one location to another. The chief point of interest in this particular trailer is the detachable front axle together with the unique manner of using four wheels on the rear axle.

Trailer and Equipment for Handling Three Heavy Reels of Wire

In handling wire in either stringing or taking down lines, the use of a trailer capable of carrying three reels at once, each weighing approximately one ton, is quite necessary. After a great deal of experimenting, the trailer shown in one of the accompanying pictures was designed and equipped as shown in another picture.

*Sub-Committee on Automotive Labor Saving Devices: P. H. Ducker, chairman; F. W. Smith, S. B. Shaw, W. H. Fairbanks, F. C. Rotsel.



(Left) Centrifugal pump attached to front of automobile and operated by the engine of the car. (Right) Container designed for taking care of small tools, records, etc., on automobiles.

This arrangement complies with all state laws and other regulations and allows the cable to be put under cover when not actually in use during construction period.

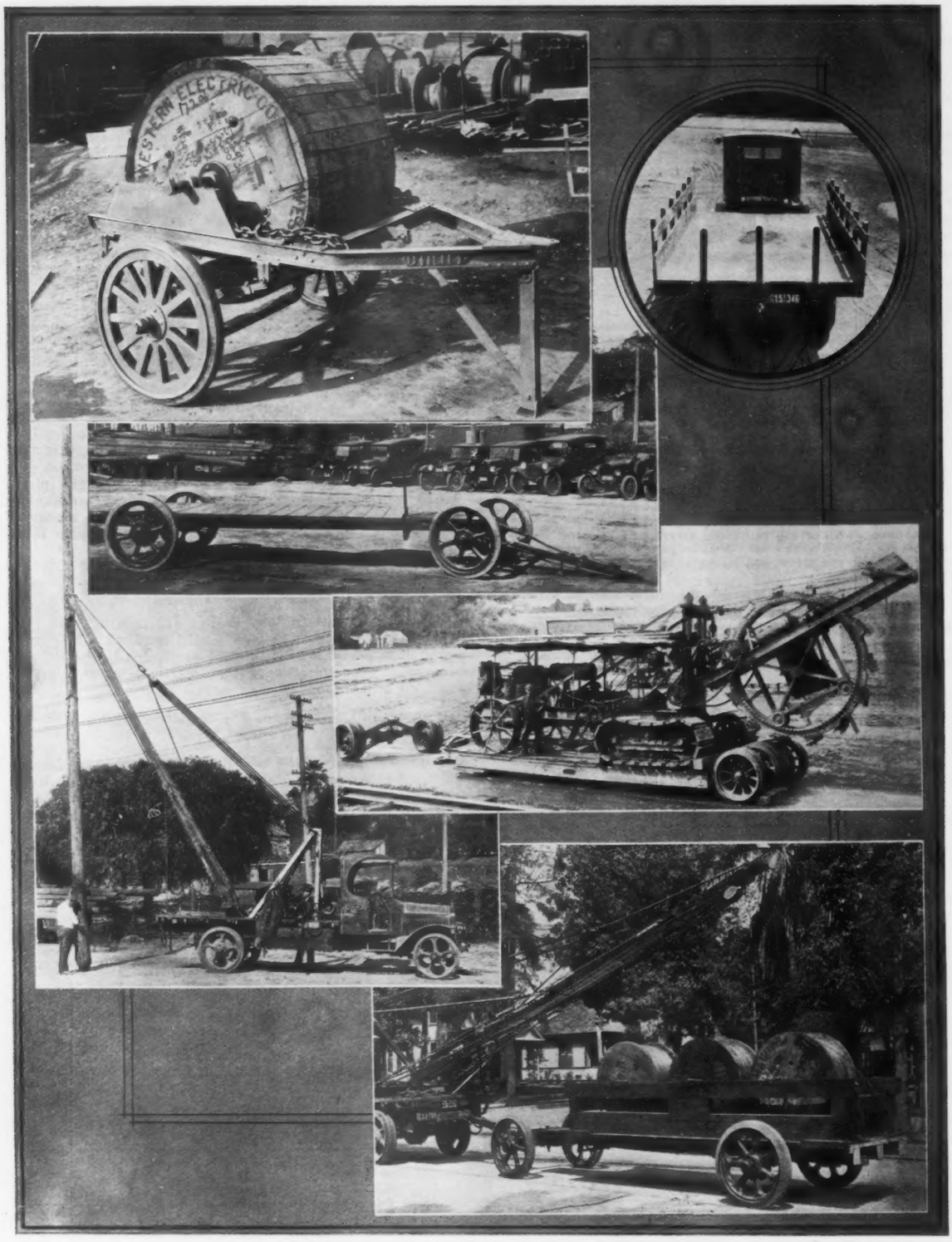
Boom for Handling Poles

Another picture shows a truck to which has been attached a power take-off having two gipsy heads extending on either side of the truck directly behind the cab. The boom is adjustable to take care of short or long poles. It will be noted that for safety reasons hemp rope has been used in all cases where the boom or lines were liable to touch any live wires when poles were being set or removed. This truck, in connection with the trailer makes a combination that has been found to be very valuable.

Trailer for Handling Cable Reels

Some of the companies are required to handle their heavy reels of cable in such a way that the loads may be shifted readily.

One photograph indicates a two wheel trailer which is so arranged by having a drop axle and rack on which an axle placed through the center of the reel rests allowing the reel to revolve when the trailer is placed in a horizontal position, lifting the reel from the ground.



Types of automotive labor-saving devices in use by California electric utilities.

Authorization and Assignment of Automotive Equipment

By J. S. MOULTON*

THIS sub-committee of the Transportation and Labor Saving Devices Committee was formed to investigate the methods employed by the various California utilities in requesting, approving and furnishing automotive equipment. Following the plan decided upon in the main committee, a recommended plan has been formulated from the practices in use, attempting to incorporate the good points and to eliminate the poor ones, or the ones which seemed applicable to only special circumstances. Of necessity, such a plan must be general in character and capable of modification in detail without change in principle if it is to be fitted into the varied organization set-ups.

The preliminary plan suggested for the consideration of the main committee follows:

Requests for and Approvals of the Supplying of Equipment

The request for equipment should emanate from the department or individual wishing the equipment, and be approved by the district (or division) manager or general office department head under whose jurisdiction the car will operate. The request should then go to the transportation department, which will,—

(a) Supply equipment, if on hand, to replace equipment temporarily out of service or for emergency use of short duration.

(b) Approve request for additional equipment if such can be furnished without purchase, indicating size and type of equipment to be furnished if request is finally approved.

(c) If additional equipment is to be purchased, the transportation department will ascertain the makes and costs of equipment meeting the requirements of size and type and make recommendations for purchase of make of equipment which, as shown by their records and in their judgment, is best suited for the work proposed.

The request, in cases (b) and (c) will then go to a designated individual, preferably a member of the executive staff who will have the authority to call for any information from any department which he may desire in investigating the need for the equipment. The principal reason for having this individual a member of the executive staff is that the chances of any inter-department friction are eliminated and the disapproval of the request, if such is the case, will be accepted without appeal. This individual will investigate the need of the equipment and make any comparisons of performance between the various districts or departments which, in his opinion, will show whether or not efficient use is being made of existing facilities and the necessity for additional equipment. He will also pass upon the make of equipment the transportation department recommends to keep the types furnished comparable between uses of like importance or prestige. Approval of the request at this point should make further approval in most cases a matter of routine.

The request may be passed from this point to the central office head of the department desiring the equipment, if this head has complete authority over the department, or directly to the general manager, if the control is more nearly centralized in his office. Upon approval of the general manager the request will go through whatever accounting routine is necessary and the purchasing department will be authorized to purchase the make of equipment specified by the transportation department in case (c) or the equipment furnished by the transportation department in case (b).

Type of Equipment

The type of equipment used in construction work, service crews and meter reading, seems fairly well standardized and their choice is well known to those interested. The use of passenger cars for the various individuals requiring them does not seem to be nearly as uniform due to varying local conditions. It does not seem wise to attempt to outline a general schedule of what cars should be furnished men in different positions as this will be determined to a considerable extent by local conditions and is in many instances a matter of company policy. It does not seem amiss, however, to suggest that there is an evident tendency in the various companies to purchase cars of a better class than have been used in the past. This practice may easily lead to difficulties in that the standard of equipment furnished will be raised throughout the company without any compensating advantages if it is not carefully watched.

*Sub-Committee on Authorization and Assignment of Automotive Equipment: J. S. Moulton.

Mileage vs. Hourly Rate as a Basis of Charge for Use of Automobiles

By P. H. DUCKER*

THE subject, "Basis for charge for use of automobiles,—hours vs. mileage," is one that requires a great deal of consideration before a decision can be made either way. From the replies received from the several utility companies in central station work, there is a decided difference of opinion as to which system is correct. Eight companies were interviewed; five use the mileage basis, while two have a combination of time and mileage, and one uses time basis only.

With reference to use of personally owned cars for company business, five do not encourage this,—in fact discourage it; one has no policy whatsoever, and two encourage the use of personally owned automobiles. The question of grouping cars of similar make, size and capacity, as compared with individual cars, to establish rates was also divided. Four companies are grouping cars and four use the individual basis.

In view of the fact that there is such a divided opinion,—and so evenly divided,—this committee wishes to offer for consideration the following suggestions.

Basis of Charging for Use of Company Automobiles

Practically the whole life of an automobile, owned by a public service organization, is used up through the number of miles the car is driven and **not** through any particular length of time it is owned by the company. Therefore it is recommended that a rate be established for automobiles for each mile the machine is driven, this rate to be made up of two parts:—first, the operating charge; and, second, the depreciation and overhead charge, the sum of the two being the service rate. The operating rate will be composed of the cost of gasoline, lubricating oil, tires, repairs, and other charges strictly accountable to operation. The depreciation and overhead rate will be made up of the figure based upon the life of the automobile, plus such overhead charges as taxes, interest, insurance, etc.

It is the opinion of the committee that this scheme is proper for the reason that the age of the machine together with the style and type of car, should not have a direct bearing on its use by the company in its business. By this we mean that a Pierce Arrow touring car that was built in the year 1916 and has only been driven 10,000 miles is as good for company use as a Pierce Arrow car built in the year 1922 that has also been driven 10,000 miles, assuming that both have been kept in the same mechanical condition.

Records for Depreciation and Hazard

It is recommended that a record of each automobile be kept on the books as a separate unit but that the cars be grouped into the various makes and sizes and that a separate rate of charge for mileage be set up for each group. We believe by this system there will be an equitable balancing at the end of a given period allowing the rate to be kept to the average on all jobs and not charging one particular job on the system a higher rate due to some one or two automobiles having been operated by careless drivers at excessive costs, while the rest of the cars in same group have been operated on a reasonable basis.

This committee is of the opinion that there should be some rate set up to accumulate a reserve to take care of accidents and wrecks in which individual automobiles are concerned. This account could be made a clearing account and if at any time there is an abnormal charge made against a certain piece of equipment due to some accident, this charge will not be reflected in the usual rates shown on the books as a cost for operating that vehicle; in other words, it would be in the nature of insurance.

*Sub-Committee on Basis for Charge, Hours vs. Mileage: P. H Ducker, E. M. Rondot.

The Arrangement and Storing of Materials

By C. A. KELLEY*

LOCATION of storerooms and storage yards will depend, to a great extent, upon the territory that is to be served and the accessibility to transportation lines. Buildings should be of fire proof material, properly ventilated and well lighted, both natural and artificial lighting being considered. The ideal building is probably of the one story type, without basement. Where ground space will not permit of one story construction proper elevators and gravity chutes should be installed. The floor should be of concrete and should be built to a car floor level if practicable. One section of the storehouse, that part set aside for the handling of very heavy material, should be equipped with traveling overhead crane, etc.

Proximity to railroad trackage is essential and convenient spurs should be arranged for, that carload shipments may be unloaded directly into the warehouse. Where plenty of space is available covered platforms and docks should be built on the track side to facilitate the unloading and handling of carload shipments. The issuing side of the storehouse should be provided with the necessary platforms, covered, built truck high so that the loading of trucks may be expedited.

When it is necessary to store stock such as poles, timbers, lumber, heavy pipe, tanks, etc., a well protected yard should be provided. This yard should be enclosed with a suitable wire fence preferably of heavy woven wire and of sufficient height to protect the property in the enclosure. When possible this yard should be surfaced, or at least that part to be used for roads and drives, and proper drainage should be provided. Covered sheds of corrugated iron can be utilized for storing bulky material not easily affected by weather and floor space so saved in storerooms can be used for other purposes.

Expansion should be given due consideration. Space that seems adequate today will be congested in a few years unless some plans are made for future growth. This pertains to all the different departments of the storeroom, office, receiving department, issuing department and the different sections of the stock rooms, etc., as well as to buildings, sheds and yards. Streets, alleys and railroad trackage should also be considered in this connection.

Arrangement

Arrangement of storehouses and yards, and the different subdivisions of same, is of the utmost importance and particularly the stock rooms and the material placed in the bins and upon the shelves. Upon an ideal arrangement depends the rapid issue of the material and the speed at which an inventory can be taken. There should be a designated place for each item and that place should be labeled, giving proper description of the article. As much of the stock as practicable should be kept in the original containers and these should be segregated as to classification, neatly piled and labeled and so stowed that inventory can be readily made at any time. Unit piling is recommended as it makes the counting much easier and expedites the taking of inventory.

We endorse last year's report which recommends the practice of sectionalizing store stock for convenience of storage and issuance of materials and we feel that the classification of articles should be made according to the nature of the article and the use to which it is to be put. Lumber should be stored near the carpenter shop, iron and steel near the blacksmith shop, pipe and large reels of wire near the shipping department, in order to lessen time and labor required in handling for shipment. Where practical, small fast moving items are put up in standard packages, to facilitate handling both at store and place of final use, outside departments ordering in this manner. Obsolete material should be segregated from useful stock.

Stock Book

The committee recommends for the control of material and supplies a stock book system to be used in addition to the stock card or stock ledger. The use of the stock book, compelling monthly inventory and checking of outstanding orders, puts the storekeeper in a position to keep his stock at a proper level. It makes it necessary for him to keep his stock in a better physical condition and it calls particular attention to inactive and obsolete stocks. The stock book sheet should be of suitable size for convenient handling when bound in book form and to properly show the following information: description of item, purpose for which required, case reference and bin number, unit, weight, average monthly consumption, quantity on order and on hand first of year, and for each month of year the quantity on hand, unfilled requisitions, quantity ordered, requisition number and date, date received.

Symbols

The use of numbers or symbols to assist in the arrangement and location of material in storerooms and the finding and handling of same after storing is to be encouraged but we do not recommend the use of symbols to designate the article to the exclusion of its proper name.

Receiving Department

A separate department should be provided for the receipt of material and all material should be handled through this department. Material upon receipt should be promptly forwarded to the proper section or department of the storeroom where it is to be stored.

Shelving

For ordinary storeroom purposes it is believed that wooden shelving properly built will serve the purpose and be less expensive than the metal shelving now on the market and will not increase the fire hazard to any great extent. Shelving should be uniform and of such height that material on top shelves can be reached from the floor without the aid of ladders. The aisles between the shelving should be wide enough to permit the moving of warehouse trucks. The shelves should have strips wide enough for the indexing of any material thereon and should be so arranged that there will be no strips or facings to aid in the accumulation of dirt. Also, sufficient width should be provided on the lower shelf which may be used as a counter and some method should be adopted that will enable the storekeeper to make rapid count of items in stock on the shelves. This can be accomplished by the use of trays, pans or the tying up of small items in standard packages or the arrangement of items on the shelves in uniform manner so that checking can easily be done. This may cause some additional work at the outset but it is believed will more than pay for itself eventually at the time of issuing stock or taking inventory.

Shelving should be well constructed, suitably strong to serve the purposes for which selected and well painted so that cleaning may be facilitated and appearance improved. Light colors should be used preferably so that the light will be reflected and dark colors used only on the part that is used as counter. A system of labeling should be installed that will indicate the name of the item stored on the shelf and this should show the same designation as used on stock records. The stock should be arranged on shelves in sections, in the same order as carried on stock records. This arrangement facilitates locating items and is a distinct advantage at inventory time.

Storage of Inflammables

All empty boxes, crates and packing materials should be stored in such part of the warehouse as will best protect the stock and reduce the fire hazard to a minimum. When large quantities of this class of material are necessarily kept on hand, storage should be provided in a separate building. Paints, oils, varnishes, gasoline and other inflammable items should be segregated from other stock and methods adopted to safeguard them. Underground storage of oils is not to be encouraged on account of difficulty in locating leaks in tanks and repairing same and, in some cases, on account of liabil-

*Storing Bureau: C. A. Kelley, chairman; Fred Hendrickson, C. B. Lore.

ity of surface water getting into the tanks. Tanks built above ground are easily inspected and leaks are soon discovered.

Responsibility

There should be one person who has the supervision of all the different storerooms if more than one are maintained by a company. All the storekeepers should look to this one person who, in turn, should be held responsible for the management and upkeep of the storerooms as well as the material and supplies of the organization.

Personnel

The employees of the storerooms, as far as possible, should be men who have had practical training in storeroom work and who have a feeling of responsibility in the handling of property. Unauthorized persons should be excluded from storehouses. Their presence only adds to the confusion incident to the receipt and issuing of material and errors are more likely to occur when employees' attention is distracted by outsiders.

Equipment

The equipment to be used in the storeroom office such as typewriters, calculating and adding machines and other labor-saving devices should be up to date and kept in good condition and should not be cast off equipment of some other department. Suitable equipment should also be used in the storeroom proper for the handling of materials and supplies and selection of the proper type is important. This applies not only to elevators, cranes, chutes, etc., but to trucks, scales and other tools and equipment necessary for handling, unpacking and packing of material.

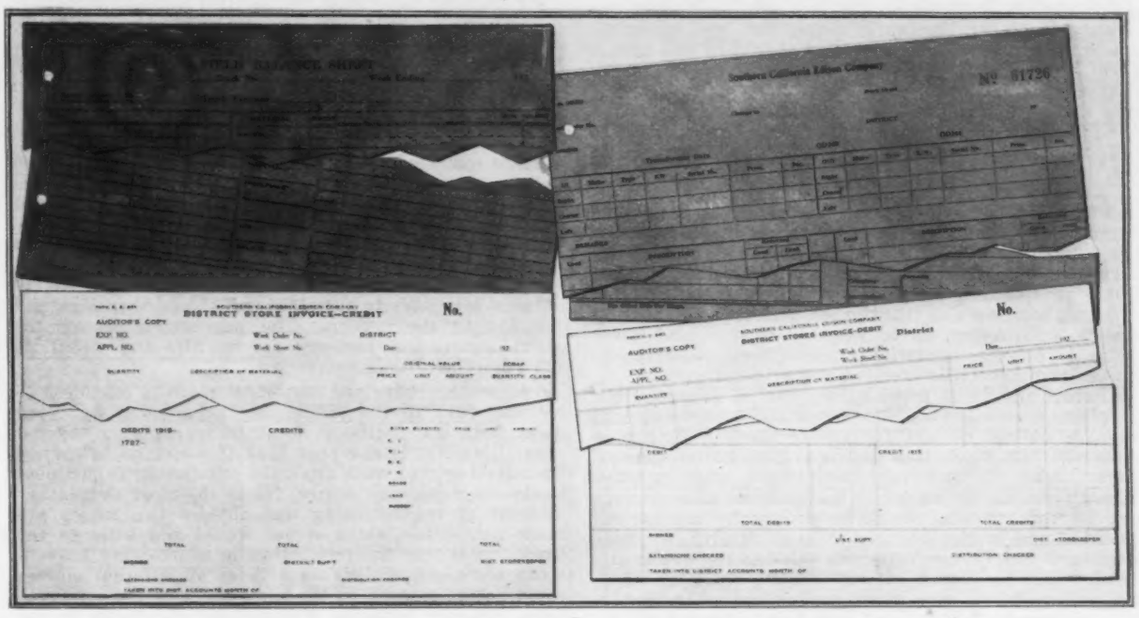
Replenishment of Stock

Where the stock book is used the storekeeper can readily figure what his wants will be for the monthly requisition and where a stock book is not kept some other means must be devised to keep the stock up to requirements. This can be handled in different ways such as the use of indicators on the stock card itself or a separate file which can be used as an order list. When records are in such shape that the average of monthly consumption can be determined with any accuracy the stock record should show the maximum and minimum quantity to be kept on hand for each item. Stock should be moved in rotation to avoid deterioration. This applies particularly to all items that are affected by climatic conditions.

Disbursements and Returns

By H. O. McKEE*

THE handling of all materials, equipment and supplies† of all departments of a company, including those carried on material trucks, shall be under the direct supervision of the stores department. Accounting for all materials, equipment and supplies shall be the responsibility of the stores department, each store carrying its own stock ledgers. All materials, equipment and supplies, whether purchased on regular purchase order, or emergency purchase order, shall pass through the materials, equipment and supplies accounts. All materials, equipment and supplies shall be actually installed in the line, or in the job, before being charged out by the stores department. The same careful attention shall be exercised in handling and accounting for junk or scrap materials, equipment and supplies, as is given newly purchased materials, equipment and supplies.



Disbursement and return forms used by the Southern California Edison Company.

A standard form shall be used as a requisition and invoice,—prepared in sufficient copies to meet requirements,—to cover disbursements between the general store and the district store. A combined form of requisition and invoice shall be used also for back orders—materials not shipped on regular requisition and invoice. Disbursements made from general or district store to line gang shall be handled on forms prepared in such a manner as to cover issues and returns for a period of one week. Copies of these forms shall be carried by the storekeeper as well as by the material clerk or line foreman on the truck. As material is placed on the line, the material clerk or line foreman will make up a report on the proper form showing quantities used on, or removed from, the line—a separate report to be made for each capital and maintenance account. From this report the store invoices shall be prepared charging or crediting the line and crediting or charging the store account with materials handled.

Daily disbursements of gasoline and oil shall be carried on a form covering company and individually

*Disbursements and Returns Bureau: H. O. McKee, chairman; O. M. Simpson, Wm. Maddock.

†EXPLANATORY NOTE: Reference is made to goods handled as materials, equipment and supplies, rather than materials and supplies. To designate wholesale distributing warehouse the report uses the term "general store." Sub-stores and division stores are referred to as "district stores." Reference made to "stores department" covers the department handling and accounting for materials, equipment and supplies of a company. The report has been condensed,—omitting the details covered by the report of last year on "Disbursements and Returns."

owned cars operating in company service for a period of one month; balanced and invoiced at the end of the month, charging each car with amounts used. Miscellaneous or emergency issues to individuals or departments not using the above mentioned forms shall be handled on a form or sub-requisition.

Materials returned from the line to the general or district store, whether usable or junk, shall be reported on the same form as mentioned above and if not re-used on the line immediately shall be returned to the store in the manner hereinbefore described. Scrap and obsolete materials should also be reported on these same forms. From these forms store invoices shall be prepared charging or crediting the line, or crediting and charging the store with the materials used or handled. At the close of each week the line foreman on the truck hands the storekeeper an actual inventory of materials left over on the truck, and the correctness of this inventory figure is determined by the balance of the previous week's work arrived at in the following manner: All materials installed on the line are inserted on the debit side of the line gang requisition, and materials taken from the line are entered on the credit side of this form, thus charging the line gang with all materials taken from the store, plus those taken from the line, and giving them credit for all materials installed on the line, plus all materials returned to the store. The difference should equal the inventory as turned in by the line gang foreman on the truck.

Return of materials, equipment and supplies by individuals or departments not using above mentioned forms shall be handled on a special form provided for the purpose. Materials, equipment and supplies returned to the general store from district store, substations, construction jobs, etc., should be handled on a form authorizing the transfer of materials and giving specific information as to whether new, second hand, scrap or obsolete materials, identifying description, proper accounts to be credited and original cost.

Forms should be provided for use of general store in placing requisitions for materials, equipment and supplies on one district for use in another district to reduce surplus stock, thus saving shipping from general store. Sales of materials, equipment and supplies through general stores, where there are no sales or commercial departments, should be covered by regular requisition and invoice charged through Sundry Accounts Receivable ledger, covering both sales to the public and employees. In district stores no sales shall be made, but will be taken care of by commercial office, materials, equipment and supplies sold being charged by the store to the sales department on regular store invoice at cost price to the store. The sales department will add the necessary overhead percentage.

When materials, equipment and supplies are returned direct to the dealer, a form for recording the return shall be used and a copy sent to the audit department giving description of material, original purchase order number and date, name of dealer, prices, etc., in order to insure receipt of proper credit for material returned from the dealer. Materials, equipment and supplies, over, short or damaged shall be covered by a form prepared in such a manner as to embody all information necessary for submission to dealers, railroads, and other carriers.

The Combined Requisition and Purchase Order

By C. A. KELLEY*

THE feasibility of combining the requisition and purchase order in one form appears upon first study impracticable and of no material saving in its adoption. The Purchasing and Stores Section, when it first discussed the project, voted unanimously, with the exception of representatives of the two companies using the same, against the combined form. These representatives adhering to the benefits, persuaded the section to refer the matter back to a special committee for further investigation and report.

In order to carry out the combination a suitable form should be provided; the original eventually to be used as the purchase order to conform to the standard purchase order form as adopted by this section, and should have a sufficient number of carbons to provide copies for those members of the organization needing same. The number of copies would vary according to the organization although possibly an original and four carbons will fit the needs of most companies. The details of the forms of the carbon-copies must necessarily conform in part to the original, but those spaces needed on the original for information peculiar to the order only, may be occupied on the carbon-copies by any information desired.

The principal benefit to be derived by combining the requisition and purchase order is in cutting down the number of times the articles requisitioned need be written and insuring accurate details from the requisitioner for the material wanted as well as doing away with the possibility of altering that description by transcribing.

The requisitioning source is expected to give the information as to the quantity, size, dimensions, make and quality of the material called for. In other words it provides an adequate description of what is required so that it may be intelligently purchased. This procedure will eliminate quite a bit of detail in the purchasing department, leaving time therein for more important matters. After the requisition is made up, the person requisitioning should retain one carbon for his information, forwarding the original and other carbons through the proper organization channels to the purchasing department. The purchasing department should fill in the original and such carbons as the routine requires, with the name of the vendor and such additional data as necessary to complete and should then sign and forward to the vendor. The purchasing department should retain the duplicate for its files and distribute the others according to routine.

As stated above the combination saves considerable clerical work in the purchasing department by doing away with the continual detail of transposing the list of articles. It is not true that this change is merely transferring that work from the purchasing department to the requisitioning source, for in the most elementary systems of requisitioning undoubtedly two copies are made and a few extra copies would add little to the work. It is true the requisitioning source may have to write more requisitions as articles of different classes could not be entered on the same sheet of the combined form, however, entering a mixed list of articles on the same requisition is poor practice even if the combined form is not used and the realization at the source that what one writes is to go to the vendor without correction will impress upon the person wishing material a necessity for greater care in ordering. Such a plan will tend to classify the material used in an organization along proper lines and will likewise tend to standardize articles to be used. A combined form will use one number throughout, thus assisting in the identifying of all communications both within the organization and with the vendor and transportation company without. It will save filing space in the purchasing department, at least, and will bring together all the matter with reference to an order.

By using this form for emergency orders through a slight deviation from the established routine, it will enable the purchasing department to have more immediate control and supervision of emergency purchase orders. Under this form the requisitioning source may fill in the vendor and deliver the original copy at once. The remaining forms taking the usual routine will, however, reach the purchasing department while the matter is still fresh and give the purchasing department an opportunity to offer such criticism as may be called for to an advantage that would not accrue under any emergency purchase routine now in effect.

The opinion of the section is that while the details of the adoption of this form may necessitate difficulties according to the organization of the different companies and the routine prevalent therein, yet the combined form has many advantages which continued use will make more apparent. The section recommends its adoption by member companies and urges at the time that the form of the order follow the standard purchase order form with the number in the upper right hand corner.

*Purchasing and Stores Section: C. A. Kelley, chairman; C. R. Eccles, J. L. Gray, F. F. Henry, John H. Hunt, Leigh S. Jones, William Maddock, D. P. Mason, H. O. McKee, William J. McCullough, George C. Robb, Frank W. Smith, R. E. Thompson, C. D. Weiss.

A Study of Underground Systems

By R. C. POWELL*

THE subject of heating of underground conduits has been under discussion by this committee for several years, but, due to the limited test data available, no definite conclusions have been reached. It is evident that all companies operating underground systems of any size must make systematic temperature surveys to avoid either excessive maintenance from burnouts or excessive capital expenditure resulting from underloaded cables.

The question of the heating of conduits has recently become a very important one to several of the larger member companies who now find it necessary to transmit underground, in one run, blocks of power of the order of 50,000 kw. or more. Two companies have made preliminary investigations on this subject including laboratory and field tests. The results obtained to date are not sufficiently conclusive for publication but indicate that the number, size and loading of cables in a conduit run of standard type are determined by a total maximum loss of 60 watts per ft. of conduit. Under certain unfavorable soil conditions this figure will be reduced to 50 watts per ft.

Studies are now being made to determine definitely, (1) the heat dissipating characteristics of the standard type of conduit, (2) if construction having greater heat dissipating ability can be designed, and (3) what can be done in the matter of cooling for the present standard type of construction.

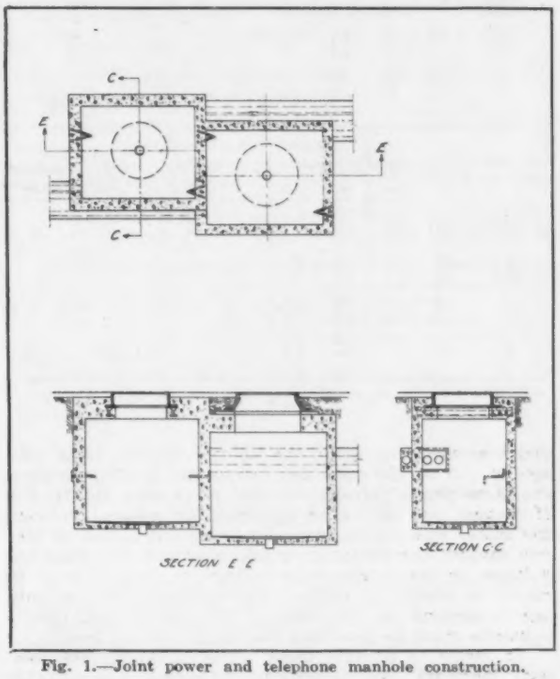


Fig. 1.—Joint power and telephone manhole construction.

Low Cost Underground Construction for Residence Districts.

In order to satisfy the demand for underground distribution in certain high grade residence tracts, companies have found it necessary to devise forms of construction cheaper than that employed in the heavier loaded districts. Experience has shown, however, that it is not possible to depart very much from standard practice. For example, attempts to use unleaded cables have, with very few exceptions, been unsuccessful. Reduced costs have been obtained in general by one of the following means:—

1—Avoiding expense of standard manholes and conduits. This has been done by installing most of the secondary system along back fence lines or in the sidewalk area with a single iron pipe for conduit and small concrete service holes.

2—By joint construction with the telephone company.

Where underground distribution is installed for residence tracts, the property or tract owners pay for the increased cost above that of overhead distribution by installing the conduit system complete ready for cables, transformers, etc., and deed same to the power company. Each property owner installs underground service at his own expense. Following is a brief description of a system installed by a member company ten years ago at the expense of the tract owner to supply a 30-acre tract subdivided into 135 lots.

Two standard transformer manholes were installed in the street which ran through the center of the tract. The conduit system consists of 2 in. black iron pipe laid along the back property lines and connects fifty-five concrete holes 30 in. long by 19 in. wide and 15 in. deep. The secondary cable consists of about 1,700 ft. of No. 1-0 Duplex and 6,000 ft. of No. 4 Duplex lead covered cable. The neutral is No. 4 weatherproof. The cost of this system complete excepting services was $35 per lot, which under present day costs would be $70 per lot.

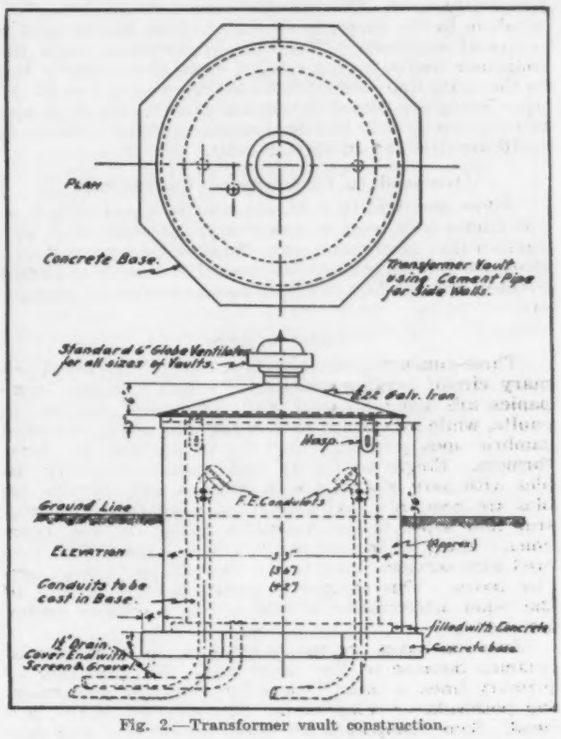


Fig. 2.—Transformer vault construction.

Two companies, with a large amount of residence underground, report that a joint construction of low cost has been worked out with the telephone company. Both companies employ the same type of construction of which the following is a description.

Manholes.

Concrete is generally used and the most common size is 4 ft. x 5 ft. x 5 ft. deep, inside dimensions. A 26 in. head with double cover for sealing is used. No reinforcing is used except in roof for supporting the head. One common wall is used between the light manhole and the telephone manhole. Manhole excavations are usually made in the street where the earth is undisturbed so that the earth wall serves as the exterior form. Two collapsible wood forms are set in the excavation with separation for the common wall and the concrete is poured around them. The side walls and roofs are made at one pouring and the heads are permanently

*Underground Systems Committee: R. C. Powell, chairman; K. B. Ayres, W. R. Battey, Clayton Biggs, M. O. Bolser, George M. Bowman, P. E. Chapman, R. R. Cowles, Geo. H. Hagar, N. B. Hinson, C. H. Jenkins, D. J. Kelly, H. G. Keesling, Raymond Lewelling, O. C. Miller, H. H. Minor, R. G. Sheppard, Vinton Smith, Ellis J. Willits.

placed to grade just prior to street paving. A tile sump is placed in the floor and pulling eyes are set in the side walls for cable pulling. The telephone and light manholes are placed end to end with a slight offset to facilitate ingress of conduits from a common trench as shown in Fig. 1. The manholes are placed at intervals varying from 300 ft. to 450 ft. depending on the lot size and closeness of proposed residences. In some hillside tracts where sharp curves are frequent, manhole adjustment is made to facilitate cable installation.

Vaults.

The vaults are the same as manholes with the following exceptions:

The inside dimensions are 5 ft. x 6 1-2 ft. x 6 1-2 ft. deep. A 30 in. head is provided to receive transformers of 50 kva. or smaller capacity. Vaults are placed at locations to permit fairly short secondary lines reaching all consumers. It seems advisable to limit secondary runs to about 600 ft.

Conduits.

Three-inch fibre duct seems to be in most common use. The light and telephone conduits have a 6 in. separation with 3 in. concrete envelope. The usual conduit section is two light ducts and one telephone duct, though sometimes it is increased to five duct section where feeder lines are required. Both light and telephone service conduits are placed in a common trench. Many installations are 1 1-2 in. galvanized iron conduit, though 2 in. fibre laid with 3 in. concrete envelope is frequently used. The service conduit is laid from the manhole to the property line at a point in line with a proposed residence. When the residence is built, the consumer continues the conduit from the property line to the main line cabinet. Where more than two 90 degree bends are placed in service conduit, the consumer must place a pull box in some accessible location to facilitate drawing in service cable.

Overhead to Underground Connections.

Fibre duct laid in 3 in. concrete envelope with 3 in. galvanized iron bend in concrete at pole with 3 in. galvanized iron riser is in use. Manhole and conduit systems are generally placed in the public streets to permit greater accessibility and less inconvenience to consumers.

Cable System.

Three-conductor lead-sheathed cable is the usual primary circuit serving residential tracts. Some companies are using all lead with waterproof systems in vaults, while others are potheading and using varnished cambric open primary buses for connections to transformers. Single conductor lead sheath secondary cables with bare neutral are in common use. Service cables are generally lead covered with weatherproof neutral, and wiped to the secondary cables in the manholes. Many of the old installations have rubber covered wire services fused to the secondaries through service boxes. This method is unsatisfactory because of the rapid deterioration of the rubber insulation underground.

Junction boxes are not in general use in residential systems because of the large cost. Sectionalizing of primary lines is usually done by means of disconnecting potheads, or disconnector lugs inserted at the pothead. Some companies are using oil cutouts with subway transformers on all lead waterproof installations, while others adhere to enclosed-type fuses and pole-type transformers in the smaller sizes and subway-type in larger sizes.

Fig. 2 shows a form of transformer vault used by one company. In the district where these are used, the residences have extensive grounds and are served by individual transformer installations supplied by primary services.

Three-Phase Underground Distribution

This is a very live subject due principally to the development of high speed elevators using alternating current motors or direct current motors supplied by field controlled generators driven by alternating current motors. It will be necessary in the future to supply a large amount of three phase power in territory now supplied largely or entirely by direct current or in territory supplied by single phase with only incidental three phase. A number of systems have been installed or proposed, and the aim of a large number of those working on this problem is to devise a system which will have (1) the reliability of the Edison direct current network and (2) to supply both single and three-phase loads from one secondary system.

A system being discussed quite extensively consists of a 115-volt four-wire Y-connected three-phase secondary network fed by transformers connected to three-phase primaries. The voltage of these primary circuits may be either 4,000 or 11,000. The transformers are connected to the network through switches which automatically open upon failure of the primary supply and are automatically closed when the primary supply is resumed.

The network is fed by a sufficient number of primary feeders and corresponding transformer banks so that failure of a feeder does not interfere with service. Furthermore, during light load periods primary feeders may be opened at the station and, since the transformers are thereupon automatically cut off, a saving in core losses may be effected.

This system meets the conditions of network reliability and single set of secondaries but has the serious

SIZES AND THICKNESSES OF INSULATION AND LEAD
600 VOLTS WORKING PRESSURE
(All Conductors to be round)

SIZE	PAPER INSULATED - LEAD COVERED						VARNISHED CAMBRIC INSULATED FLAMEPROOF BRAID
	1 Conductor		2 Conductors		3 Conductors		1 Conductor
	Ins.	Lead	Ins.	Lead	Ins.	Lead	Ins.
2000 M	4/32	9/64					4/32
1500 M	4/32	1/8					4/32
1000 M	3/32	1/8					4/32
750 M	4/32	1/8	4/32	1/8			4/32
500 M	4/32	3/32	4/32	1/8	2/32 x 2/32	1/8	4/32
250 M	3/32	3/32	3/32	1/8	2/32 x 2/32	1/8	4/32
1-0	3/32	5/64	3/32	3/32	2/32 x 2/32	3/32	
2	3/32	5/64	3/32	3/32	2/32 x 2/32	3/32	
4	3/32	5/64	3/32	3/32	2/32 x 2/32	3/32	

SIZE	RUBBER INSULATED-LEAD COVERED							
	1 Conductor		2 Conductors		3 Conductors		Control Cable 5, 7, 9 or more conductors	
	Ins.	Lead	Ins.	Lead	Ins.	Lead	Ins.	Lead
2000 M	1/8	9/64						
1500 M	1/8	1/8						
1000 M	7/64	1/8						
750 M	7/64	1/8	7/64	1/8				
500 M	3/32	3/32	3/32	1/8	3/32	1/8		
250 M	3/32	3/32	3/32	1/8	3/32	1/8		
1-0	5/64	5/64	5/64	3/32	5/64	3/32		
2	2/32	5/64	2/32	3/32	2/32	3/32		
4	2/32	5/64	2/32	3/32	2/32	3/32		
8	3/64	1/16	3/64	1/16	3/64	3/32		
10	3/64	1/16	3/64	1/16	3/64	3/32	3/64	3/32

Table I.

disadvantage that, with the normal single phase voltage of 110 to 120 volts for lamps and heating devices, the three-phase voltage for motors is only 190 to 208. If motors are not to be operated at reduced voltage, the motor manufacturers must bring out a line of 200-volt motors, compensators must be provided to raise the voltage, or the single-phase voltage to neutral must be raised to about 127 volts. Furthermore, with a voltage to neutral of 120 volts or 208 volts delta, special elements must be provided for large heating loads.

In order to obviate these disadvantages, one company provides two secondary networks, one 127/220 volts for power and the other 110/190 volts for lighting. Both are supplied from the same banks of transformers, the voltages for the power secondaries being raised by means of compensators placed in the manholes or vaults with the banks.

A number of companies are employing single-phase 3-wire secondaries for lighting and single-phase power, small 3-phase power from open delta secondaries by running a so-called power leg fed by a transformer from another phase, and large 3-phase loads by individual banks which in time may be interconnected by 3-phase secondaries to increase reliability. The proper system for any company to use depends a great deal upon local conditions and the form and extent of the distribution system that is now used.

Standardization of Sizes and Thicknesses of Insulation and Lead.

Most companies have found it desirable and economical to limit the number of sizes of cables purchased and it is believed that the industry will profit if all companies will use a common standard. A questionnaire

SIZES AND THICKNESSES OF INSULATION AND LEAD

2500 VOLTS WORKING PRESSURE

(All Conductors to be Round)

SIZE	PAPER INSULATED - LEAD COVERED					
	1 Conductor		2 Conductors (Fig. 8)		4 Conductors	
	Ins.	Lead	Ins.	Lead	Ins.	Lead
1000 M	6/32	1/8				
750 M	6/32	1/8				
250 M	5/32	3/32	5/32	1/8	4/32 x 3/32	1/8
2/0	5/32	3/32				
1-0	5/32	3/32				
2	5/32	5/64	5/32	3/32	4/32 x 3/32	7/64
4	5/32	5/64	5/32	3/32	4/32 x 3/32	7/64

4500 VOLTS WORKING PRESSURE

CONDUCTOR		PAPER INSULATED LEAD COVERED		VARNISHED CAMBRIC INSULATED FLAMEPROOF BRAID	30% HEVEA RUBBER INSULATED LEAD COVERED	
		3 Conductors		1 Conductor	1 or 2 Conductors	
Size	Shape	Ins.	Lead	Ins.	Ins.	Lead
2000 M	Round			6/32		
1500 M	"			6/32		
1000 M	"			6/32		
750 M	"			6/32		
500 M	"			6/32		
500 M	Sector	4/32 x 3/32	1/8			
400 M	"	4/32 x 3/32	1/8			
250 M	Round	4/32 x 3/32	1/8	6/32		
1-0	"	4/32 x 3/32	1/8	6/32		
2	"	4/32 x 3/32	3/32	6/32		
4	"	4/32 x 3/32	3/32			
10	"				6/32	1/16

7000 VOLTS WORKING PRESSURE

CONDUCTORS		30% HEVEA RUBBER INSULATED LEAD COVERED	
Size	No.	Insulation	Lead
8	1 or 2	8/32	5/64

Table II.

covering this subject was sent out. The following information was received.

1—Do you follow a standard specification for ordering insulated cable?

Four of the six companies to whom this questionnaire was sent have standard specifications which cover their practice in ordering cable.

2—Do you use all sizes of wire and cable, or is it your practice to use only the more common sizes that are carried in Pacific Coast stock?

All companies eliminate to some extent certain sizes of cables.

3—Do you adhere closely to manufacturers' recommendations as to thickness of insulation and lead sheath?

All companies adhere quite closely to the manufacturers' recommendations, but most companies add more insulation than the manufacturers specify.

4—What are the different voltage ratings of cable that you use?

Most of the companies adhere closely to the manufacturers' classifications, which are:

600 volts and under
600 volts to 1,500 volts
1,500 volts to 3,000 volts
3,000 volts to 5,000 volts
5,000 volts to 7,500 volts
7,500 volts to 13,500 volts
13,500 volts to 18,000 volts
18,000 volts to 21,000 volts

5—Do you use both varnished cambric insulation and impregnated paper insulation in high voltage cables?

Most companies use impregnated cable with lead sheath. However, a few use varnished cloth, and several in submarine work use rubber insulation.

6—Is it your practice to demand certified test reports on all orders of cable, both electrical and mechanical?

Only three of the six companies specify test requirements.

SIZES AND THICKNESSES OF INSULATION AND LEAD

11,000 VOLTS WORKING PRESSURE

CONDUCTOR			PAPER INSULATED LEAD COVERED		VARNISHED CAMBRIC INSULATED		
					FLAMEPROOF BRAID	LEAD COVERED	
					1 Conductor	1 Conductor	
Size	Shape	No.	Ins.	Lead	Ins.	Ins.	Lead
1500 M	Round	1	10/32	1/8	10/32		
1000 M	"	1	10/32	1/8	10/32		
750 M	"	1	10/32	1/8	10/32		
500 M	"	1	10/32	1/8	10/32		
500 M	Sector	3	6/32 x 4/32	9/64			
400 M	"	3	6/32 x 4/32	1/8			
400 M	Round	1				10/32	7/64
250 M	Sector	3	6/32 x 4/32	1/8			
250 M	Round	1	10/32	7/64	10/32		
2/0	"	1	10/32	7/64		10/32	7/64
2/0	"	3	6/32 x 4/32	1/8			
2	"	1	10/32	7/64	10/32		
2	"	3	6/32 x 4/32	7/64			
6-8 or 10*	"	4-6 or 8*	6/32 x 6/32	1/8			

*For street lighting circuits only

Table III.

7—Do you specify that the sheath shall have a certain small percentage of tin or other metal?

All companies specify commercially pure lead on small or medium size cables, but in cables of large diameter there are some companies that specify a small percentage of tin in the sheath.

It is the opinion of the committee that it is entirely feasible for all the companies to agree upon a standard specification covering the sizes, thickness of sheath in lead covered cables. This, however, will take further time but should be concluded by the next committee.

Tables I, II and III give the standards in use by one of the larger companies. These, with certain minor revisions, have been in use for several years with satisfactory results.

Employment Methods of the Electric Utilities of California

By S. C. HAVER, Jr.*

THIS report is based on information obtained by means of a questionnaire sent to electric utilities of California. The following eight companies replied, six of which gave more or less complete information:

Coast Counties Gas & Electric Company
Great Western Power Company
Pacific Gas and Electric Company
San Diego Consolidated Gas & Electric Company
San Joaquin Light & Power Corporation
Southern California Edison Company
Southern Sierras Power Company
Western States Gas & Electric Company

General Organization

Five of the larger companies report centralized employment, three of them under a comprehensive personnel department organization, the fourth principally along the lines of employment work with some other personnel functions and the fifth along the lines of employment for certain departments only. Some of the smaller companies have a junior executive who is delegated to look after employment matters. The nomenclature "Personnel Department" is generally used, the manager of the personnel department reporting direct to the general manager. One large company uses "Employment Department" and "Supervisor of Employment."

The personnel or employment department has general supervision of all employment for the company and handles all classes of applicants. Remote districts usually hire locally under its supervision. With one company the employment department serves only certain departments of the company, other departments doing all hiring on an independent basis. Employment for construction is frequently handled on a more or less independent basis although one company reports complete organization of special employment offices for this class of hiring.

Records

The following records are generally maintained in the personnel or employment department.

* Application for employment
* Record of physical examination
* Reference letters and replies
** Notice of employment
* Progress reports
** Change of rate
** Change of occupation
** Termination of service

* The original goes to the personnel department—copies to other departments if information needed.

** The original goes to paymaster for payroll records with copy to personnel department.

One company reports all records filed with payroll department.

Method of Listing Vacancies

Three companies require that all vacancies be listed with the employment department, but two companies make listing optional. Two companies require that re-

*Personnel Committee: S. C. Haver, chairman; (R. J. Baker, chairman, resigned), G. L. Bell, H. Dewes, R. C. Eccles, W. H. Ellison, E. J. Kendall, E. G. McCann.

quisitions for help be made in writing with detailed specifications of the job but the more general practice seems to be to handle orders and job specifications informally, usually by telephone. The department ordering invariably fixes the rate, the employment department acting in an advisory capacity only.

Methods Used in Securing Applicants

Companies having employment departments show an intelligent use of all available sources. The following methods used are named in the order of their preference as a source of satisfactory applicants.

1. Introduced by employees.
2. Calls at employment office.
3. Help wanted "ads."
4. Schools and colleges.
5. Hired direct on the job.
6. Private and public agencies.
7. Scouts and handbills.

Where the employment department is well organized many jobs are filled from applications on file.

Methods of Selection

All companies require a written application. The responsibility for selection rests with the department placing the order. No company reported the use of trade, clerical or mental tests to any extent. Reference letters are not considered as dependable information but inquiries are made of former employers after hiring, as a check in regard to honesty and accuracy of statements made on application. Three companies reported requiring physical examination for all positions, one company requires examination for all positions in the permanent organization but makes exceptions in some cases of construction labor.

Function of Employment Department After Hiring

The employment department usually assumes the responsibility of giving the new employees general information in regard to the company's policy and employee activities and introduces personally or by note to the department in which they are to work. Three companies have a regular follow-up system as to employee's progress. The others follow up informally when practicable. One company is undertaking a very comprehensive job analysis and rating system.

Transfers

Three companies require all transfers from one department to another, to be made through the personnel department. Two companies do some work along these lines but their system is not complete.

Terminations

Terminations are generally initiated in the department where employee works. Three companies require approval or review by personnel department before termination is effective and all companies but one consider the personnel department as a court of review or appeal in any case of dismissal.

Shipment to Construction Job

Various methods are followed in regard to handling shipments, depending upon the labor market conditions. As a general rule the fare to the job is advanced when necessary. Refunding this fare in 30, 60 or 90 days is resorted to as a measure to assist in getting men when labor is scarce. Sometimes "free fare" is offered as an inducement. Employment of train-riders to see that shipments get through to destination is frequently resorted to, especially in the case of large shipments. One company has effected a considerable saving in the cost of securing labor over a considerable period of varying labor conditions, by shipping without train-rider, fare advanced, deducted, no refund. Baggage is checked to camp destination to protect against men leaving the shipment enroute.

Summary

Companies which have had experience with centralized employment departments seem satisfied with results so far attained and the tendency seems to be toward further centralization. One company is now installing a complete personnel department and expects to work out a systematic employment plan. Smaller companies are adopting modified plans for handling employment work along those lines.

Central Station Power in Competition with Fuel Engines

By W. C. JOHNSON*

THE subject assigned covers all types of fuel engines. It was decided by the sub-committee, however, that for the purposes of this paper only such engines would be considered as might offer competition to central station power. On this basis gasoline engines were eliminated from consideration.

Gas Engines.

In general, gas engines only furnish competition where natural gas is available and then only when the installation is so located as to have gas available at a very low cost, or at no cost. It is the experience of California oil companies who have used gas engines that in order to get adequate reliability and reasonably low maintenance, units must be limited in size to about 300 hp. This means a large fixed charge for an installation of any considerable size.

The figures of one California oil company, that has an installation of some 500 kw. in several small units, where a charge of 5 cents per 1,000 cubic feet of gas is made, show a cost of 1.08 cents per kw-hr. for power generated.

Where small gas engines are used directly to mechanically drive their load, and where the gas available can be considered as having no value, no general statement which would be generally accepted can be made as to the lower cost of central station power. Figures available, however, definitely lead us to the conclusion that even under these circumstances central station power can in many cases be demonstrated to be cheaper than "free gas."

Steam Engines and Steam Turbines.

The sub-committee was agreed that steam engines, and steam turbines furnished competition for central station power only under one of the following special conditions:—

(a) Where a considerable amount of steam is required, in any event, for heating or other plant processes.

(b) Where fuel is available in sufficient quantities, for which there is no sale, and which, if not burned under the boilers, would have to be burned as waste.

No general statement can be made relative to business falling under the above two classifications. Each installation would have to be considered as an individual problem to determine whether or not in that particular case the total cost of central station power would be cheaper than the private plant.

One thing is certain, however, and that is that today installations of this character go in with electric drive, and all past experience indicates that ultimately such installations go on the lines of the central station.

In many cases where steam is used for plant processes it can be shown that electric power itself can be used for heating, and the whole process so improved that power cost is a minor consideration.

For the small plant with waste fuel such as the planing mill, central station power can usually prove

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itself to be cheaper than the private steam plant and a market for much of the supposedly waste fuel can frequently be found.

The lumber mill where suitable quantities of slab or hog fuel are available is the place where the steam plant will usually make the best showing. For large enterprises of this character, however, the power requirements are such as to make the steam plant a considerable central station in itself. Under these circumstances it would seem reasonable to predict that in many cases a power company will take over the purely central station end of the business, buying fuel from the lumber company and selling them their power requirements. As this would usually result in the plant being tied in to the power company's system as a whole, such an arrangement should be mutually beneficial to the central station and the lumber company.

Diesel and Semi-Diesel Engines

Conditions will sometimes warrant an installation for standby service, even where central station power is used. It has been called to the sub-committee's attention that under these circumstances Diesel engine manufacturers have, in many cases, been pushing the Diesel engine for such standby service. Inasmuch as a relatively large part of the power cost for Diesel engines consists of fixed charges it is obvious that, where such a standby installation is made, the central station service will tend to become the standby. It would seem obvious that, where such an installation is contemplated, it should only be necessary to call attention to the fact that the Diesel engine would offer the most expensive possible form of standby service. For such an installation the prime mover that should be installed for standby service would of course be the one which could be put in for the lowest first cost, which would in no case be a Diesel engine.

The Diesel engine plant will show to the best advantage where the load factor is high. Many plants for the manufacture of ice will operate at a very high load factor and such installations would show the Diesel to the best advantage.

Plants of this character generally represent a sufficiently large investment to warrant a careful engineering investigation on the part of the ice manufacturer, and the fact that in California practically all ice plants are using central station power speaks for itself.

Some power companies report considerable competition from semi-Diesel engines in small sizes for irrigation service. In some cases full-Diesel engines in sizes around 100 hp. have also been offered for this service.

For this reason it was thought that it might be helpful for the sub-committee to compile a report showing comparative costs for such installations and this is given in the appendix.

Figures were made up for a specific location, namely, Salinas, California. The cost figures used are the best actual figures obtainable for the particular location, both for machinery and fuel.

The number of hours operation per year is typical for irrigation service, as indicated by power companies' records for this class of service.

Inasmuch as some items of cost will vary considerably with the location, and the correct values for other items will be subject to considerable difference of opinion, the exact values used for each item are given. This means that other figures for other locations can easily be substituted for those used and a proper result for any location obtained.

The sub-committee does not mean that Diesel and semi-Diesel engines can be operated for the costs given. It does aim to show, however, what the comparative costs would be, on a basis that is liberal to the oil engine, and also to present a tabulation that will make it easy for a similar comparison to be made under any other assumed set of conditions.

Plants of 25 hp., 50 hp., and 100 hp., are considered and costs computed for central station power and semi-Diesel engines. Costs are also given for a full-Diesel engine for the 100 hp. size.

The total hours of operation per year are taken as the equivalent of 720 hours at full load.

Under these circumstances, the yearly cost of the 100 hp. plant is found to be $2,369 for the full-Diesel plant; $2,104 for the semi-Diesel plant, and $1,534 for central station power. For the 50 hp. plant, the yearly cost is $1,222 for the semi-Diesel engine, and $840 for central station power, and for the 25 hp. plant, the yearly cost is $681 for the semi-Diesel engine, and $475 for central station power.

For the two smaller plants it is interesting to note that central station power would still be considerably cheaper if the fuel cost nothing.

Appendix

For the purpose of this paper three moderate sized plants were assumed, namely, 100 hp., 50 hp., and 25 hp., and the pumping load in each case was assumed to be such that the brake horse power output of the prime movers would be equal to their rated capacity; that is, they would operate at full load while running. The total time of operation per year was taken as 720 hours during an irrigation season of approximately five months and it was presumed that the plants on the average would be run eight hours per day for ninety days during the season.

In order to estimate the cost of the various type plants erected and to figure the cost of fuel and electricity, some locality had to be assumed and the Salinas Valley was chosen as the point. The investment in plant indicates the cost of the prime movers, delivered and erected, ready to operate, and the cost of housing, but does not include the cost of the well or pump machinery or necessary belt, as these were presumed to be the same whether driven by motor or engine and would therefore not alter the relative costs of central station and oil engine drive. In order to get a fair comparison of costs all cases were based on belt drive, though if motor equipment was decided upon, direct connected motors would probably be installed.

PLANT INVESTMENT, INCLUDING HOUSING
(Exclusive of Pump End)

Size Plant	Full-Diesel	Semi-Diesel	Motor
100 hp.	$9,700.00	$6,700.00	$1,207.00
50 hp.	.....	$3,900.00	$ 810.00
25 hp.	.....	$2,090.00	$ 564.00

Fixed Charges

	Full-Diesel	Semi-Diesel	Motor
Interest on investment	6 Per Cent	6 Per Cent	6 Per Cent
Depreciation	7 Per Cent	8 Per Cent	4 Per Cent
Maintenance	3 Per Cent	4 Per Cent	1½ Per Cent
Taxes and insurance	1½ Per Cent	1½ Per Cent	1½ Per Cent
TOTAL	17½ Per Cent	19½ Per Cent	13 Per Cent

Operation

The fuel required for the engine is Diesel oil weighing 6.6 lb. per gal. and the consumption per b. hp. hour will be taken as 5/10 lb. for the 100 hp. full-Diesel, 6/10 lb. for the 100 hp. semi-Diesel, 7/10 lb. for the 50 hp. semi-Diesel and 8/10 lb. for the 25 hp. semi-Diesel engine. These are believed to be very fair allowances for plants in operation for a year or more, though slightly better fuel economy may be attained on new engines. In figuring the kw.-hr. consumption of the motors, the following efficiencies were taken for full load operation: 100 hp. = 91 per cent; 50 hp. = 90 per cent; and 25 hp. = 89.5 per cent.

Fuel and Electricity

Size	Full-Diesel	Semi-Diesel	Motor
100 hp.	5,454.5 gal.	6,545.4 gal.	59,024 kw.-hr.
50 hp.	.....	3,818.1 gal.	29,840 kw.-hr.
25 hp.	.....	2,181.8 gal.	15,003 kw.-hr.

Electricity—The cost of electric power will be figured in accordance with the filed schedules of the Coast Valleys Gas & Electric Company, which apply in the territory chosen, as follows:

Size of Installation	Initial Charge 200 kw.-hr. or less per hp. per year.	Rate per kw.-hr. for energy used in excess of 200 kw.-hr. per hp. per year: Next 800 kw.-hr. per hp. per year.	Next 2000 kw.-hr. per hp. per year.	All over 3000 kw.-hr. per hp. per year.
2- 4 hp.	$9.90	2.5c	1.4c	1.0c
5- 14 hp.	$9.00	2.0c	1.2c	.9c
15- 49 hp.	$8.40	1.8c	1.1c	.9c
50- 99 hp.	$8.10	1.6c	1.0c	.8c
100-249 hp.	$7.60	1.5c	.9c	.8c
250 hp. or over	$7.50	1.4c	.8c	.7c

In no case will the total minimum charge be less than $19.80.

Fuel oil.—Diesel oil in tank cars (about 6500 gal.) would cost f. o. b. Salinas $.0509 per gal.; in carload of drums (35 drums of 110 gal. = 3,850 gal.) $.0766 per gal., and in drums less than carload lots $.0960 per gal. As the size of the plants under consideration would hardly warrant the investment in storage facilities and the interest on the cost of a year's supply or more of fuel oil, and as a carload of drums would present similar difficulties, the price of l.c.l. shipment would be adopted as the one best applying to the conditions under consideration. In addition to the price on siding, some carrying charge would have to be added and the total cost per gal. delivered to the plant would probably be in the neighborhood of 11 cents. In the interest of simplicity, however, the cost will be figured as 10 cents per gal. delivered, as corrections can be made very easily from this figure.

Lubricating oil.—For both the full and semi-Diesel the cost will be taken as 15 per cent of the cost of the fuel oil. In the case of the motors, the cost is assumed to be $1.00 per year, which is in excess of what it actually would be.

Attendance.—For the 100 hp. engines, about 180 hours per year of a farm hand's time would be taken and for the 50 and 25 hp. engines about 90 hours per year. For the motors (all sizes) 45 hours per year has been assumed and is considered liberal. The base rate of pay for a farm hand is taken as 25c per hour.

Annual Operating Cost—100 hp. Plant

	Full-Diesel	Semi-Diesel	Central Station Power
Fixed charges	$1,697.50	$1,306.50	$ 156.91
Fuel or electricity	545.45	654.54	1,365.36
Lubricating oil	81.82	98.18	1.00
Labor	$45.00	45.00	11.25
Total	$2,369.77	$2,104.22	$1,534.52

Annual Operating Cost—50 hp. Plant

	Semi-Diesel	Central Station Power
Fixed charges	$760.50	$105.30
Fuel or electricity	381.81	722.44
Lubricating oil	57.27	1.00
Labor	22.50	11.25
Total	$1,222.08	$839.99

Annual Operating Cost—25 hp. Plant

	Semi-Diesel	Central Station Power
Fixed charges	$407.55	$ 73.32
Fuel or electricity	218.18	390.06
Lubricating oil	32.73	1.00
Labor	22.50	11.25
Total	$680.96	$475.63

A Study of Prime Movers

By J. G. ROLLOW*

THE earliest record of petroleum oil being used as fuel for the generation of electricity, on the Pacific Coast, is found in the newspaper files of the early eighties. In the Los Angeles Express of Aug. 1, 1883, we find the following:

"At the Electric Light Works a furnace is set up for burning crude petroleum. * * * A reservoir is at some distance away, and a pipe in the form of a siphon extends into the firebox and is punctured with small holes. Heat is applied to it underneath, at the bend in the pipe, which changes the oil into gas, after which a burning rag saturated with oil is thrown into the firebox and the door closed. It immediately ignites and burns with the noise and fury of a furnace with blast on."

The Steam Atomizing Burner.

It was soon realized that in order to burn fuel oil successfully in large quantities it was necessary to break it up into small particles, and steam atomizers were shortly afterwards developed. In the early days considerable attention was given to the design of the atomizer and very little to the furnace. Inventors came forward with almost every conceivable arrangement, until the patent office had about fourteen hundred different varieties of steam atomizing oil burners on record. The steam atomizing burner is an excellent burner and the highest boiler efficiencies on record were obtained with it. However, it requires a large furnace volume for its performance and its efficiency drops off very rapidly with increased ratings. (See Fig. 1.)

In 1901 E. H. Peabody, at the Valencia Street power house, in San Francisco, departed from the usual practice of introducing the burner through the boiler front by placing the burner at the bridge wall and firing toward the front. This method allowed the expanding products of combustion to move in the direction in which the cross sectional area of the furnace was increasing, thus recognizing the importance of furnace design. But the rear shot steam burner arrangement in the standard furnace did not give high efficiencies at high ratings.

The Mechanical Burner.

Soon after the close of the European war coal prices were the highest ever known and fuel oil went down in price, due to the laying up of many vessels. Up to that time no oil burner had been developed for stationary service, which would give the high ratings of forced draft stokers at equal efficiencies. Consequently there was a demand for a high capacity, high efficiency, oil burner. The mechanical atomizer was introduced into stationary work and developed further to meet this demand. The Pacific Coast has been slow to adopt the mechanical atomizer for central stations. The first of this type were put into operation by a member company in 1922.

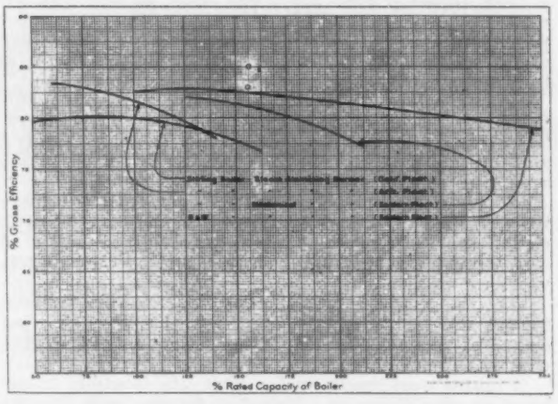


Fig. 1.—Showing efficiency of steam and mechanical atomizing oil burners at various ratings.

The principal difficulty encountered in its operation is the maintenance of the furnace brickwork—especially the floor. Fig. 2 shows an inexpensive and effective method of protecting the floor. The best method of protecting the walls has not been determined. Some eastern companies are using water screens, such as shown in Fig. 289 of the 1923 National Prime Movers Committee report. Others are trying the air cooled wall. It is the opinion of the best engineers that if the air method protects, that it is preferable for proper combustion. The radiant superheater is being used in some pulverized coal plants for furnace side wall protection. In designing a furnace it is desirable to keep the burners as far from the walls as practicable. Figs. 3 and 4 show effects of mechanical atomizers on nearby brickwork. Engineers have suggested that direct flame impingement is responsible for most of the brickwork trouble. It is believed that if burners and furnace can be so arranged that the combustion is entirely complete before any brickwork or heating surface is touched, that brickwork troubles will be reduced to a minimum, and the highest efficiency obtained. It would be well for the committee to make some studies along this line.

*Prime Movers Bureau: J. G. Rollow, chairman: C. F. Braun, E. E. Valk, R. F. Monges, H. S. Markey, P. M. Robinson, R. F. Leefeld, C. E. Steinbeck, R. C. Powell, C. H. Delaney, M. E. Mulkey, C. W. Wiggin, M. C. Wheyland, A. D. Murphy, R. A. Wallingford, A. Y. Meydell, C. P. Rhine, E. A. Quinn, G. Z. Ogden, Leo Kraps, C. R. Stewart, W. E. Thompson, V. E. Johnson, George M. Wills, F. V. Wright, C. L. Davis, A. W. Copley, R. A. Hopkins.

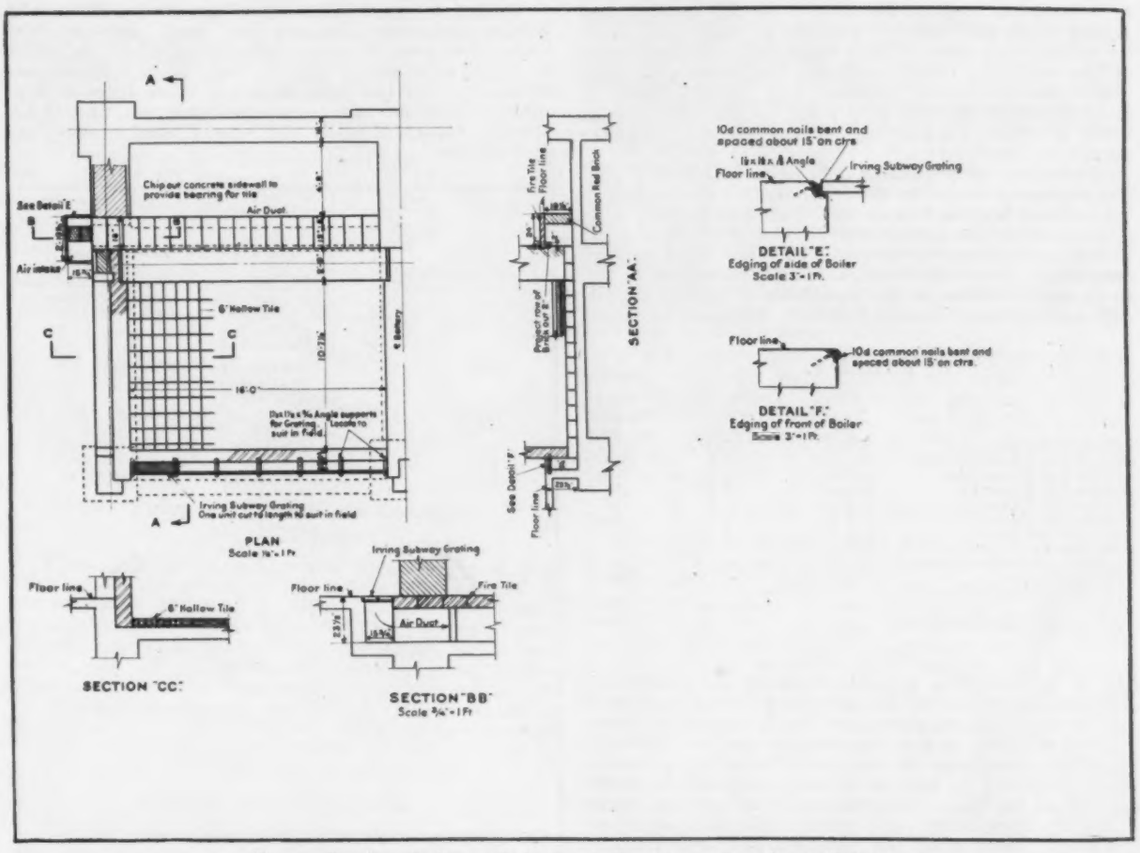


Fig. 2.—Showing effective method of protecting furnace floors by ventilation.

Furnace Volume.

All engineers agree that the general tendency in furnace design, on the Pacific Coast, has been toward insufficient volume for high efficiencies at ratings beyond 125 per cent. Just what the economical furnace volume is, has not been determined. Table I gives the furnace volumes per rated boiler horse-power of several representative plants. One company is designing a plant which will have 4.2 cu. ft. of furnace per rated hp. This installation will be of interest because of the liberal combustion space, this being about the same as used with forced draft stokers. The best design of furnace will be that one which more nearly allows the complete combustion of the fuel before the flame comes in contact with either the brickwork or the heating surface. If, by the use of forced draft or other means, the combustion can be speeded up, then the furnace need not be so deep or high, as when the process requires a greater element of time. The shape and size of the furnace will then depend upon the amount of fuel to be burned in a given time and the characteristics of the burners used.

Automatic Regulation and Instruments

Several automatic controls have been tried by member companies but the success of these has not been phenomenal. Two members, however, report good results with the Moore system. There is a tendency in boiler rooms today to use more measuring instruments —both indicating and recording. The modern boiler room has instruments for determining at least the quantities and temperatures of fuel and water, carbon dioxide, and flue gas temperatures, besides the usual pressure gauges.

The gas burner in common use is some modification of the Bunsen. All of the companies using gas seem to

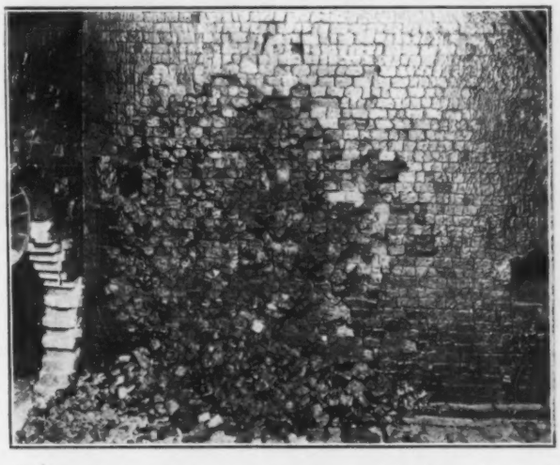


Fig. 3.—Showing effect of erosion from mechanical atomizing oil burners on side wall.

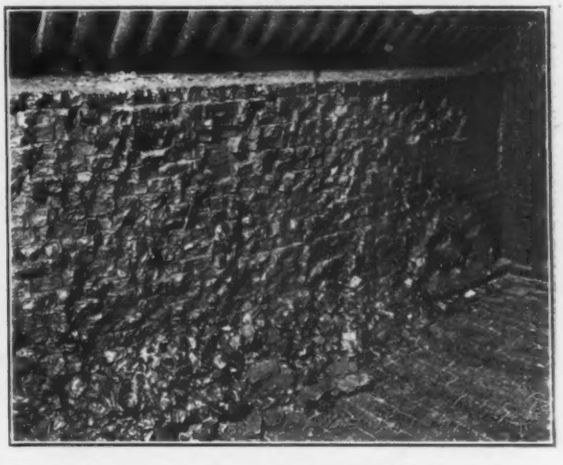


Fig. 4.—Showing effect of erosion from mechanical atomizing oil burners on bridge wall.

have tried out some of the designs on the market, and finding them not entirely suitable to their case, have developed their own. These home-made designs seem to give excellent results at home, and some very high efficiencies have been obtained with them. Table II gives results of several tests made by the San Joaquin Light & Power Corporation on their burner arrangement.

There are no particular difficulties in burning gas. The brickwork seems to last indefinitely. One company using water high in sodium salts had some trouble with priming, when the burners covered the entire floor area. This was overcome by covering only the front half of the furnace floor with burners. Small variations in the gas pressure bother in the regulation of the air supply with low pressure Bunsen burners. This can be taken

TABLE I.

Name of Company	Name of Boiler	Cu. Ft. of Furnace Volume per HP.	Usual Rating Per Cent
Southern Cal. Edison Co.....	Stirling	1.9	145
Southern Cal. Edison Co.....	Stirling	1.9	145
Southern Cal. Edison Co.....	Stirling	1.84	160
Southern Cal. Edison Co.....	B. & W.	1.3	150
Southern Cal. Edison Co.....	B. & W.	1.3	150
Pacific Gas and Electric.....	B. & W.	2.26	...
Pacific Gas and Electric.....	Stirling	2.77	...
San Diego Consolidated Gas & Electric Company.....	B. & W.	1.92	200
L. A. Gas and Electric Corporation.....	Stirling	3.01	155
L. A. Gas and Electric Corporation.....	B. & W. under construction	4.2	...

care of by installing a good regulator (of which the Chapman-Fulton is one), at each boiler, with ample size pipe between the regulator and the burners. If there is a real difficulty in burning gas it is the fact that under certain conditions the supply is liable to fail, making it necessary to keep a furnace equipped for both gas and oil burning. The problem is to keep one kind of burner from being destroyed while the other is operating. Here again the members have shown individuality and have worked out their own problems to a large extent.

Combination Furnaces

Where front shot oil burners are used a good combination is that shown in Fig. 416 of the report of the National Prime Movers Committee for 1923. The Southern California Edison Company uses the Bunsen

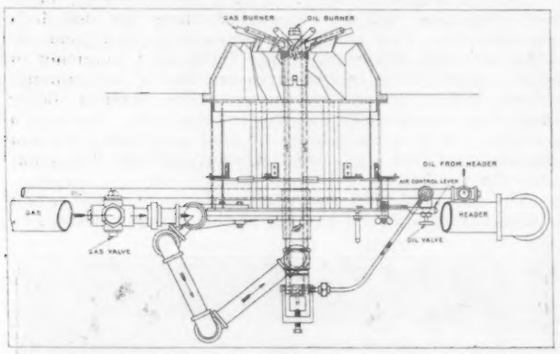
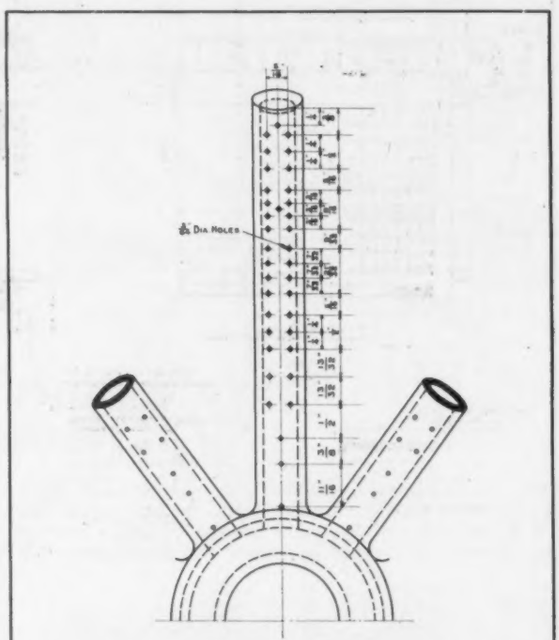


Fig. 5.—Showing combination B. & W. Santiago type mechanical oil burner and Los Angeles Gas & Electric Corporation high pressure gas burner.

gas burner in the front half of the furnace floor in conjunction with the Hammel rear shot oil burner arrangement. This combination gives good results where oil is burned infrequently and for short periods of time. If oil is burned for any considerable period (60 days), the gas burner tubes will have to be renewed. This is not expensive but means the loss of the boiler.

During the past year a combination of a Babcock & Wilcox mechanical atomizer and high pressure gas burner has been developed (See Figs. 5 and 6), which is giving satisfactory results, both as to capacity and efficiency. The test here shown is taken from a large number made on this burner, burning gas, and is believed to represent fairly well what it does in every day performance.



VIEW SHOWING HOLES IN GAS BURNER.

Fig. 6.—Showing holes in gas burner.

Test of Boiler Equipped with Combination Burner Shown in Figs. 5 and 6

Date	Jan. 31, 1924.
Duration	5 hours
Boiler type	Stirling-Integral economizer.
Number of burners	8
Fuel	Southern California natural gas.

Dimensions and Properties

Furnace volume (cu. ft.)	2684
Water heating surface	8900
Superheater surface	1369
Economizer surface	2403
Ratio of furnace volume to heating surface	1 : 3.32

Average Temperatures, Pressures, etc.

Superheated steam pressure (gauge)	250 lb.
Temperature of feedwater	195 deg. F.
Temperature of exit flue gases	430 deg. F.
Temperature of superheated steam	522 deg. F.
Degrees of superheat	116 deg. F.
Boiler room temperature	70 deg. F.
Gas pressure at burners	6 lb.
Gas temperature	70 deg. F.

Flue Gas Analysis

Carbon dioxide, per cent by volume	11.2
Oxygen, per cent by volume	2.3
Carbon monoxide, per cent by volume	0.0
Nitrogen, per cent by volume	86.5

Gas Analysis

Carbon dioxide	.9%
Methane	73.9%
Ethane	23.6%
Other hydrocarbons	.8%
Oxygen	.1%
Nitrogen	.7%
Specific gravity	.7%
Heat value (per cu. ft.)	1,210 B.t.u.

TABLE II. Tests made by the San Joaquin Light & Power Corporation at Midway steam plant.

Kind of burner	San Joaquin Stirling	San Joaquin Stirling	San Joaquin Stirling	San Joaquin Stirling	San Joaquin Stirling	San Joaquin Stirling
Size of boiler	823 hp.	823 hp.	823 hp.	823 hp.	823 hp.	823 hp.
Volume of furnace	2,000	2,000	2,000	2,000	2,000	2,000
Area of heating surface	8,230	8,230	8,230	8,230	8,230	8,230
Ration furnace volume to heating surface	1:4.1	1:4.1	1:4.1	1:4.1	1:4.1	1:4.1
Per cent of boiler rating	86.5	106.1	107.0	110.6	139.0	160.0
Per cent efficiency of boiler and furnace	79.7	80.1	79.2	82.9	81.1	77.7

Total Quantities

Total gas used	312,142 cu. ft.
Total weight of water fed to boiler	291,075 lb.
Total heat of one pound of steam	1,109.9 B.t.u.
Factor of evaporation	1.1289
Total equivalent evaporation F. & A. 212 deg. F.	328,595 lb.

Hourly Quantities and Rates

Gas consumer per hour	62,428 cu. ft.
Gas consumed per cu. ft. furnace volume per hour	23.3 cu. ft.
Water evaporated per hour	58,215 lb.
Equivalent evaporation F. & A. 212 deg. F.	65,719 lb.
Gas burned per burner per hour	7,804 cu. ft.

Capacity

Boiler hp. (Builders rating)	890
Boiler hp., including economizer surface @ 10 sq. ft. per hp.	1,130
Boiler hp. developed per hour	1,750
Per cent boiler rating developed	197
Per cent rating developed based on total surface	155

Efficiency

Efficiency based on gas as fired	85.5%

Heat Balance

Heat absorbed by boiler	85.50%
Loss due to burning hydrogen	2.17%
Loss in dry chimney gases	6.37%
Loss due to moisture in atmosphere	.07%
Radiation and unaccounted for	5.89%

Sea Water vs. Cooling Tower Condenser Cooling Systems

When considering the proper location for a new steam plant somewhere to the south or southeast of and within 25 or 30 miles of the city of Los Angeles, the question of whether a coast location, with salt water for condenser cooling, or an inland location, near a load center, with a fresh water cooling system would be the better, was made the subject of considerable study. In the following paragraphs an attempt will be made to describe briefly the method of attacking the problem with particular reference to condenser cooling systems, their efficiency, reliability and operation costs.

Factors to Be Considered.

The plant sites considered were, first, a coast location much similar to the present Long Beach steam plant location, and some five miles from a load center, at which the generated energy could profitably enter the distribution system; and, second, an inland location close to the load center. The factors of land values, fuel, transportation facilities, fresh water supply, living conditions, etc., were considered equal in the two cases, leaving the problem one of balancing the extra cost of fresh water cooling systems operation against the cost of transmitting the power for five miles from the coast location to the load center.

Selection of Practical Size of Cooling Tower

A study of weather records over a period of years and some investigation of cooling tower performance, and manufacturer's guarantees, gave reason to believe that a certain cooling tower installation would give practically the same average cooling water temperatures as would be obtained with ocean water, at the expense, however, of about double the pumping costs plus other tower operation costs.

Such a large increase of cooling system operating costs would not be justified ordinarily. A compromise point at which less water will be handled and prime mover operation will be at higher back pressure may be found which will be the most economical operating point. At this point the loss due to greater steam consumption of the prime mover will be equalized by the saving in cooling system operating costs.

It must not be expected, however, that a practical cooling tower system can ever be operated at as low cost as a salt water system except under very unusual conditions. The tower system will have the disadvantage of large land area, an expensive structure, and high pumping head.

Advantages of Tower

The saving out of which the cooling tower operating expenses may come is made in transmission expenses. Another point at which a saving may be made is in condenser and pump maintenance. With salt water the corrosion and pitting of condenser tubes, pump runner, etc., is frequently severe, not only because of the corrosive action of salt water, but also because of the fact that in many cases polluted water must be used. Also the usual location of pumps and condensers above normal water level and their operation with syphon maintained to lower the pumping head, puts a negative pressure on both pump suction and condenser tubes, causing cavitation in the pump and ready separation of dissolved gases (ordinarily some 31 per cent oxygen), in the tubes, which accentuates pump and tube corrosion.

In cooling tower systems the condenser and pump are usually so located that a positive pressure is maintained on all parts of the condenser; also, fresh water is seldom corrosive. Scaling of tubes may occur but may be prevented by proper treatment of the cooling water. Another factor to be considered is the action of salt water leakage into the condensate upon the boilers. Where evaporated feed make-up is not used this pollution of condensate may not cause trouble because of alkali salts in the make-up water.

The intake conduit system for salt water must be cleaned frequently and the intake and outlet so built as to stand wave action. Seaweed and drifting sand troubles are frequently serious. Fresh water tunnels seldom need cleaning but algae growth in the tower and basin may become troublesome, although it is usually easily controlled.

Type of Tower Considered

The type of cooling tower considered was the atmospheric type which is used where the wind blows fairly constantly. With proper wind conditions there is good reason to believe that this type will give very nearly the greatest possible cooling, hence the lowest practical temperatures. Some question as to the ability of the tower to perform as guaranteed was dispelled by tests of numerous towers in service. The inland location was situated where the ocean breeze blows nearly constantly, but not always. This factor of unreliability must be taken into account, particularly for a base load plant. The cooling is largely by evaporation so that make-up water must be supplied in amount equal to one-half to two or three times the weight of steam condensed, depending upon the loss as spray and the humidity of the air. The cost of this make-up water and its treatment must be considered.

Sample Calculation—Efficiency and Costs

For purposes of calculation we will assume certain conditions which are more or less fictitious. Land value $500 per acre for cooling tower; basin and tower foundation cost $25,000 per acre; pumping head, sea water 25 ft.; cooling tower system 50 ft.; steam costs 30c per 1,000 lb.; transmission lines for 70,000 kw. $18,000 per mile; transmission losses 0.2 per cent per mile; cooling tower costs for cooling 90,000 gal. per min. 91 deg. to 75 deg., $200,000; land required, 8 acres; power costs 0.4c per kw.-hr.

Cooling system maintenance costs, annual, 70,000 kw.
Salt water system, $80,000.
Cooling tower system, $20,000.
Taxes, 2%; depreciation, 4%; interest on investment, 7%.
Load factor, 92%.

Absolute back pressure—
Salt water system, 1.2 in. mercury.
Cooling tower system, 1.9 in. mercury.

Prime mover steam consumption—
Salt water system, 9.82 lb./kw.-hr.
Cooling tower system, 10.24 lb./kw.-hr.

Cooling water pumped—
Salt water system, 140,000 gal. per min.
Cooling tower system, 90,000 gal. per min.

From the above assumed values we calculate as follows:—

Cooling water pumping expense:—

Salt water system—
140,000 gal. per min., 25 ft. head, 70% efficiency.
960 kw., $31,000 annual cost.

Cooling tower system—
90,000 gal per min., 50 ft. head, 70% efficiency.
1,211 kw., $39,100 annual cost.

Prime mover steam consumption:—
10.24—9.82=.42 per kw.-hr. more for cooling tower system=$71,200 annual extra cost.

Cooling tower fixed costs:—

Cost of tower	$200,000
Cost of tower land	4,000
Cost of tower basin	200,000
Total	$404,000

Interest 7% on $404,000=	$28,280
Taxes 2% on $404,000=	8,080
Depreciation 4% on $400,000=	16,000
Total annual fixed cost	$52,360

Transmission line:—

5 miles at $18,000 per mile, $90,000.
Interest, depreciation and taxes=13%=$11,700.
Losses, 0.2% for 5 miles=1%=$22,600.

Annual operating costs $34,300 for transmission.

Make-up-water:—

Salt water system:—

Boiler feed make-up only (2%)=28 gal. per min.
Cost, $0.03 per M. gal. plus treatment at $0.04 per M. gal.=$0.07 per M. gal., $950 annual.

Cooling tower system:—

Total make-up (including boiler feed make-up)=100% boiler feed, 1,400 gal. per min.
Cost, $0.01 per M. gal. plus treatment $0.04 per M. gal.=$0.05 per M. gal.=$33,900 annual.

Comparison— Annual Operating Costs

Cooling System	Salt Water	Cooling Tower
Tower-fixed charges	$	$ 52,520
Pumping	31,000	39,100
Cooling system and condenser maintenance	80,000	20,000
Extra steam consumed in Prime Mover	.....	71,200
Make-up water	950	33,900
Transmission	34,300	.....
Totals	$146,250	$216,720

Some smaller items have been purposely omitted in order to shorten this report.

The comparison of operating costs indicates that with conditions as stated the load center would have to be about fifteen miles or more from the coast justify the inland location. If, however, condenser maintenance of the salt water system should be double the amount stated, the inland location would be justified at about five miles or more from the coast.

Reliability

The most uncertain factor about the cooling tower system is the wind velocity. The record of weather conditions over a number of years at or close to the proposed location should be studied carefully and proper allowance made in design to care for such interruptions in cooling as are likely to occur.

In the salt water system the danger of unreliability lies in the necessity for frequent shutdowns for condenser repairs to prevent excessive salt water leakage into the condensate.

Summary

The outstanding advantages of the two systems are:—

Salt water system:—

1. Colder water, higher vacuum.
2. Lower pumping heads.
3. Somewhat more reliable.
4. Lower first cost.

Cooling tower system:—

1. Lower condensate maintenance cost.
2. Locate near load center.

Some Condenser and Cooling Water System Data and Maintenance

Long Beach steam plant of Southern California Edison Company. Data for seven years, 1916 to 1922 inclusive.

Total generation	974,450,000	kw.-hr.
Average annual generation	139,207,000	kw.-hr.
Rated capacity of plant	47,000	kw.
Units operating time	44.7%	of total
Load on units while operating	75.6%	of rated
Total output	33.8%	of maximum possible

Condenser Maintenance

All tubes Admiralty metal.

Total tubes in plant	18,260
Renewals, total (7 years)	15,906
Renewals, annual	2,272
Tube life, actual	8.04 years
Tube life based on maximum possible use	2.72 years

Annual Cost

New tubes, (Less scrap value) at $4.10	$ 9,316.36
New tube sheets (Less scrap value)	1,062.35
Labor, repair gang	7,317.12
Total	$17,695.83
Cost per kw.-hr. generated	$ 0.000127

Cooling System Maintenance

Repairs to circulating pumps, annual	$2,600
Repairs to sand pump	400
Repairs to screens, jetty, etc.	1,800
Cleaning intake tunnel	1,200
Total	$6,000
Cost per kw.-hr. generated	$0.000043

Overhead Construction and Operation

By R. R. COWLES*

THE work of the Overhead Systems Committee for this year has been divided among four sub-committees. The reports of these sub-committees are included in the following report. A few items of general interest are noted below.

220-kv. Operation

Since the report of last year's Overhead Systems Committee, the 220-kv. lines of the Pacific Gas and Electric Company have been placed in operation between Pit River and Vacaville. These lines were first raised to full potential in Oct., 1923, and in the latter part of November were placed in actual operation at this voltage and have been operating satisfactorily up to the time of the preparation of this report. The Pit River lines consist of two circuits, of which 60 miles are single circuit flat configuration supported by snow towers as illustrated in Figs. 1 and 2. Of this 60 miles, 28 miles of the conductor is steel core aluminum 1 in. outside diameter, equivalent in conductivity to 325,000 cir. mil copper. The remaining 32 miles is 500,000 cir. mil rope lay stranded copper, as is also the remainder of the circuit from Cottonwood to Vaca. One hundred and forty-two miles of this line in the valley territory is constructed on double circuit steel towers of which Fig. 3 is an illustration. Fig. 4 illustrates two circuit transposition structure.

The insulator string consists of 13 units, nine of which are standard 10-in. suspension type discs. The remaining four consist of two 10-in. special units and two 14-in. special units and at the lower end of the string there is a corona shield 16 in. in diameter. The anchor strings are designed for an ultimate strain of 20,000 lb. One interesting feature of this structure is the fact that less than 4 per cent of the insulator units are in dead end position.

A more detailed report of the Pit River transmission lines and their operation will be presented at the convention in June.

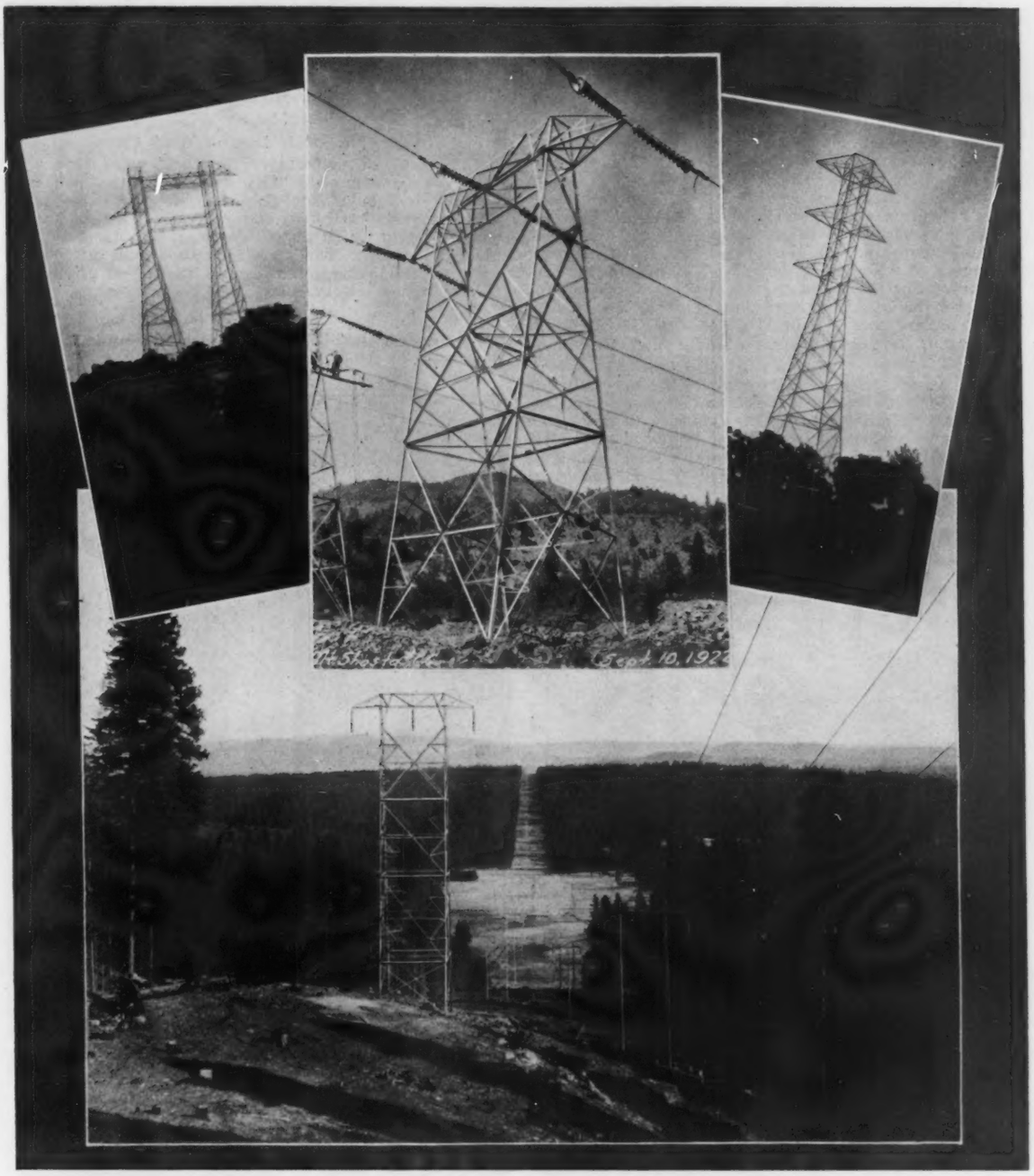
Standardization of Pole Line Material

Through the efforts of the Overhead Systems Committee of the National Electric Light Association considerable progress has been made in the standardization of pole line material, particularly line hardware. The manufacturers have cooperated to a considerable extent in this work and it is to be noted that the number of types and sizes has been very materially reduced. This committee has worked with the national committee towards this end and it is anticipated that considerable saving can be effected by following the standards prepared by the national association.

Regulations Covering Line Construction

General Order 64 has been in effect since July, 1922, and sufficient time has elapsed to make it possible to determine to what extent these rules are workable. No formal changes have been made since this order became effective, although certain rules have been informally modified due to difficulty in complying, and certain devi-

*Overhead Systems Committee: R. R. Cowles, chairman; R. E. Cunningham, H. Mitchener, N. B. Hinson, F. G. Hamilton, L. J. Moore, E. R. Banks, D. D. Smalley, G. M. Bowman, E. A. Quinn, L. J. Corbett, Walter Dreyer, C. E. Young, E. H. Steele, George Hagar, E. R. Northmore, E. C. Taylor, C. B. Judson, R. B. Ayres, C. L. Lawrie, E. D. Sherwin, E. N. D'Oyly, P. O. Crawford, R. S. Daniels, O. G. Steele, W. R. Van Bokkelen, T. W. Snell, E. K. Gwym, F. W. Paul, E. C. Gerrey, C. A. Henize, G. A. MacDonald, M. O. Bolser, R. V. Sheilds, S. L. Case, R. F. Conlisk, Wm. Winter, M. H. Schnapp, M. S. Barnes, B. G. Hatch, G. E. Honn, H. G. Sharp, W. A. Hillebrand, E. Y. Porter, A. C. Putnam, P. W. Greenleaf.



Figs. 1, 2, 3 and 4.—Showing types of steel towers used by the Pacific Gas and Electric Company.

ations have been permitted in special cases as these have come up. In general it appears that the rules are entirely workable and with certain minor changes will lead to a better type of construction, greater safety to the linemen and still be consistent with economy. Among the difficulties that have been encountered, those which stand out most prominently, are the working space requirements, climbing space, and attachment of guys and grounds to poles. Methods of hanging transformers have been the subject of considerable controversy but this condition is gradually being cleared up. Apparently there is need for some minor revision.

The National Electric Safety Code is now in process of revision, those sections dealing with clearances, climbing space and conductor loadings being given most attention. The California orders have been subjected to very close scrutiny by the national association and much interest has been shown in the practical workings of these orders.

The subject of distribution transformer polarity, after having been the cause of a great deal of discussion in the past years, and after having been apparently settled, has again come up for reconsideration. It was again brought up this year in the National Overhead Systems Committee and referred to the overhead systems committees of the various geographical sections. At the Fresno, Calif., meeting it was unanimously agreed that the Pacific Coast Overhead Committee desired to retain the present standard of additive polarity for all distribution transformers of 200-kva. and below in the lower voltages. Similar action was taken in the Overhead Systems Committee of the National Electric Light Association at the Birmingham, Ala., meeting. It is earnestly hoped that no change will be made in the standards for distribution transformers since the large amount of confusion, which would necessarily result from such a change, would more than offset any possible saving or convenience which the proponents of this change might hope to effect.

Report of Sub-committee on Substitutes for Wood Poles

By L. J. CORBETT*

AT the October meeting of the Overhead Systems Committee, it was decided that the sub-committee should be appointed to make a study of possible substitutes for wood poles. In order to form a basis for substitution, it was decided that the sub-committee should "make a comparison of wood, steel and concrete poles, using factors of safety, spans and loadings which would give comparable results." The matter of the treatment of wood poles above the ground line for protection against white ants was to be a subject for study by the sub-committee, but this has been given very complete treatment in the National Electric Light Association Report of the Overhead Systems Committee of 1922 and 1923.

The rising cost of wood poles and the necessity for replacement due to natural rot and damage from insects make it advisable for the industry to determine without further delay, the status of the wood pole itself and of possible substitutes therefor, in some if not all situations. A total of about 140,000 cedar poles of

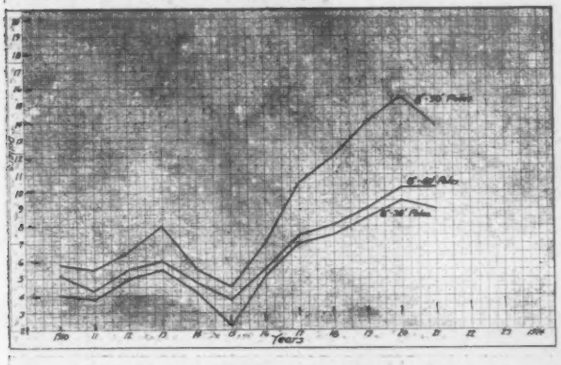


Fig. 1.—Fluctuation in the price of wood poles by years.

greater than thirty ft. in length were used in California in 1923. Over 900,000 cedar poles were cut in the Northwest including Canada, the greater portion of which were shipped to points east of the Mississippi River.

In Oregon and Washington the timber growth is large in size and poles are a by-product of logging operations and often neglected, or at best let out to sub-contractors ahead of the logging. This source is, therefore, closely tied up with logging operations. In the Inland Empire, consisting of eastern Washington and northern Idaho, poles are a more important product, and pole supply companies have their business thoroughly organized, with cruisers out, pole timber bought years ahead, storage yards at shipping points, and some have treating plants. These companies are going farther and farther back into the woods for their poles year by year, with consequent higher costs to get them to the shipping points. Virgin territory still exists in the Clearwater country in Idaho, in Western Montana, in inland British Columbia and along the west coast of Canada. Estimates place the supply as sufficient for from 15 to 20 years with increasing prices. If prices go too high, substitution of southern pine (in eastern markets), full treated fir, Port Orford cedar and other woods will be a regulating factor. Western red cedar, however, is favored by operating companies and will probably be adhered to as long as economically possible.

The curves (Fig. 1) showing the average pole prices at Sand Point, Idaho, indicate the price trend without reference to freight charges. Prior to 1915 the eastern demand was not so heavy as it is now, labor was cheaper and more efficient, and sources of supply were closer to the railroads than at present. It is believed the price level will not increase so rapidly in the next few years as it has since 1915.

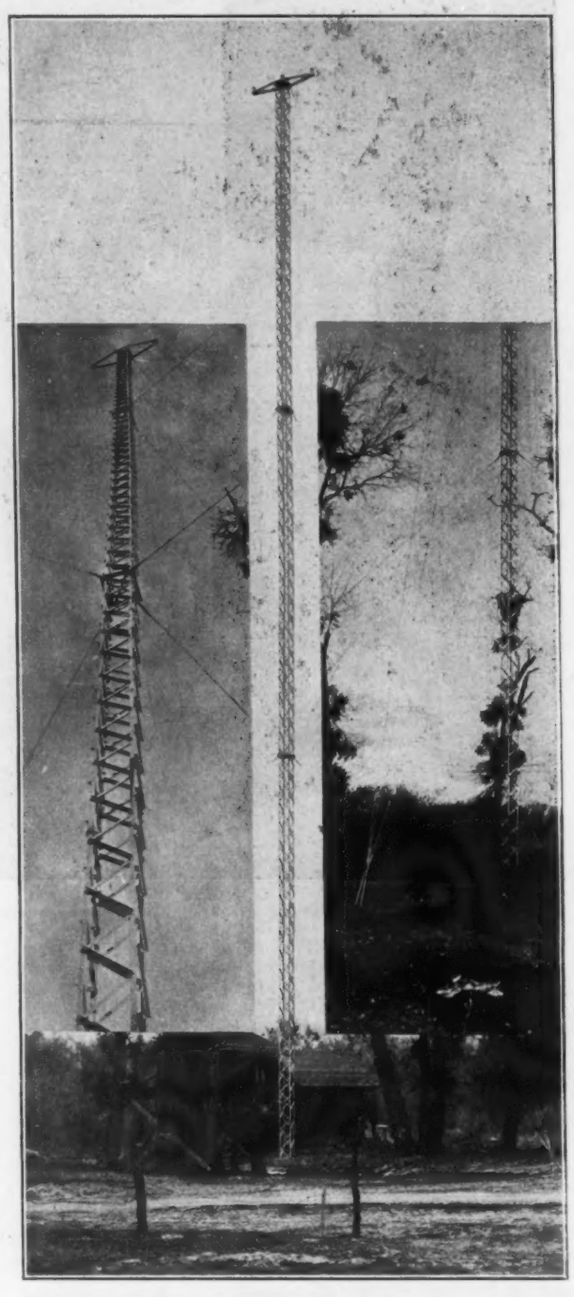
Butt treatment of poles is becoming more popular as prices advance, about 90 per cent of poles now used being butt treated as against only 60 per cent in 1914. Two of the power companies are now trying out orders of fully creosoted fir poles.

Possible Substitutes for Wood Poles

The possible substitutes for wood poles are not many. The committee has gathered data upon concrete poles, tubular steel poles and structural steel poles as complete substitutes, and concrete stubs as partial substitutes to which wood poles may be attached above the ground line. The structural steel pole offered the greatest possibilities, and formed the subject of most of the committee's work.

Present Status

Concrete Poles. These have met with some measure of success in street lighting and for trolley poles, all in



Steel river crossing mast 155 ft. high. The insert at the left shows method of attaching guy wires and the one at the right, method of anchoring.

*Sub-Committee on Substitutes for Wood Poles: L. J. Corbett, chairman; K. B. Ayres, R. E. Cunningham, H. S. Daniels, E. H. Steele, C. E. Young, C. E. Mardell, J. S. Moulton, E. Y. Porter, W. Dreyer, C. B. Carlson, H. G. Sharp.

Types of steel poles used by California companies. Top (left to right), Southern Sierras steel pole, erected; steel footing on same type of pole; Western States Gas & Electric Company pole. Bottom (left to right), pole on Riverside line of Southern Sierras Power Company; latticed pole used by Southern Pacific Company, Oakland; pole used by Turlock Irrigation District.

cities or parks, but the extreme weight and consequent transportation expense of sizes necessary for the loadings of suburban lines, renders them impracticable for the general use contemplated by the committee. Concrete poles are also used in substation yards by operating companies, but these are generally few in number, of special design and therefore costly.

In 1914 the City of San Francisco contracted for 94 concrete poles for the Church Street railway extension at $52 each. The bids ranged from $30 to $95 each. Prices at the present time will be about double the 1914 prices. The Van Ness Avenue poles cost about $135 each in place with ornamental top and base.

Concrete poles erected in substation yards of the Pacific Gas and Electric Company have cost $144 each for 18 poles, at Claremont, in 1922, to $175 each for three poles, at Knights Landing. These are the direct construction costs.

Tubular Steel Poles. These are also used in special locations and as trolley poles. They must be set in concrete, and be galvanized or painted.

Bates Expanded Metal Poles. These are in use to some extent in the East and to a limited extent in California. Guys must be installed at frequent intervals.

Structural Steel Poles. These have been used to a considerable extent by operating companies and by railroad companies for special uses, but special designs are the order for the varied requirements. This means expense of design, delay in fabrication, and uncertainty of the product or repeated tests. Among the types of steel pole used in California are the following:

The Southern Sierras Power Company used a 40-ft. steel pole, 2 ft. square, weighing 820 lb. including a pipe cross-arm at the top for flat construction, 33 kv. It has a special tapered footing designed for setting in earth without concrete. These poles are used on 300 ft. spans. They are designed for a test load on the top of 2,000 lb. and a torsional load at the end of the cross-arm of 1,000 lb.

The Turlock Irrigation District uses a steel pole 3 ft. 6 in. square at the base, 1 ft. 9 in. square at the top and 60 ft. high carrying two 1/0 stranded copper circuits with suspension insulators for 66,000 volts. Spans vary from 500 ft. to 700 ft. The weight is 2,300 lb. including cross-arms and footing material for a concrete setting. A similar pole is being made for the Western States Gas & Electric Company but with an earth footing. The latter pole weighs 2,500 lb.

The Great Western Power Company has had successful experience for a number of years with a 60 ft. steel pole weighing 1,976 lb. on concrete footings, on its line feeding Richmond. The company has "repeated" by using a somewhat similar pole 52 ft. high weighing 2,000 lb., also set in concrete, to supply the filtration plant in Sacramento. The pole is designed for two circuits of 1/0 copper and to withstand two broken wires.

The Pacific Gas and Electric Company has used structural steel guyed masts to replace wood over some navigable sloughs; costs comparing very favorably with those for wood. There were erected near Marysville quite recently six 100-ft. and two 155-ft. high, at a field cost averaging approximately $656 for the 100-ft. and $1,010 for the 155-ft. masts. These figures may be compared with recent costs of wood masts, four 140-ft. masts, in January 1920, averaging $526 each, and one 185-ft. wood mast, in September 1921, costing $1,964.

Shipment is best made on steel poles by assembling the opposite faces, the other members and cross-arms being shipped loose, but marked for ready assembly in the field.

Among the advantages to be gained by having standard steel poles for certain loadings are the following:

Saving in cost due to eventual elimination of the design charge.
Saving in cost due to quantity production.
Ability to procure from stock or on quick orders.
Constancy in characteristics of all poles of a given class.
Life and maintenance of original strength.
Freedom from attack of termites and birds.

As the first step in the sub-committee's work, an outline of the important features was made and submitted for discussion at the Los Angeles meeting in December, 1923. Nothing definite came of this discussion owing to the great variety of opinions as to just what loading a steel pole should be designed to withstand. It was the general opinion that a steel pole, through serving as a substitute for a wood pole, should be designed to withstand heavier loading. In addition, it was felt, that, in general, the field of use for the steel pole was not in the distribution network of congested communities, but only in long span construction such as transmission lines and rural distribution lines.

The size of conductor in use on 60-kv. lines usually varies from 1/0 to 4/0 copper, or equivalent in aluminum. The insulators are of either the pin or suspension type. With the suspension type, (assuming 5 units and 400-ft. spans), the load which the pole must actually resist in the event of a broken wire, is reduced to about 60 per cent of the maximum stress in the wire, owing to the insulator swinging into and becoming a part of the catenary. For 4/0 copper with a maximum stress of about 20,000 lb. per sq. in. or 3,340 lb. per wire, this reduced stress becomes 2,000 lb. With the pin type insulator, there is no similar relief except through the bending of either the pin or the cross-arm, or from the wires slipping in the ties. Some tests were made at the bureau of tests of the Pacific Gas and Electric Company to determine the load at which slippage through the ties occurs. The complete record of these tests follows. The first group of tests was made expressly to determine the point at which slippage would occur on 60-kv. insulators using standard tie construction. The second group was made to determine the slippage of weatherproof and bare wire as used on 11-kv. construction. It will be noted that for bare wire the ties will usually slip at about 1,000 lb., although there is no positive guarantee that slippage will occur.

A. Tests on 60-kv. Insulator Ties

Test No. 1. 71,000 cir. mil cable and No. 6 soft drawn tie wire. No tension in cable while tie was made. Ties made loose without using pliers.

Pull

175 lb. Cable pulled through wire.
560 lb. Cable pulled through wire.
550 lb. Cable pulled through wire.
230 lb. Tie wire slipped over insulator—Final pull 340 lb.
270 lb. Tie wire slipped over insulator—Final pull 530 lb.
460 lb. Cross-arm split.

Test No. 2. No. 1/0 standard cable and No. 6 soft drawn tie wire. Loose standard ties made without pliers; 680 lb. applied to cable while making ties.

Additional pull required for slipping of wire, 320, 357, 205 and 270 lb.—Average 285 lb.

Test No. 3. No. 1/0 standard cable and No. 6 soft drawn tie wire. Loose standard ties made without pliers; 375 lb. applied to cable while making ties.

Additional pull required to cause slipping, 300, 110, 110 lb. Average 170 lb.

B. Strain Test on 11-kv. Insulator Ties

Three different sizes of wire, No. 4/0 medium hard drawn weather proof, No. 6 medium hard drawn (bare) and No. 4 medium hard drawn (bare) were used as the conductors with several sizes of wire as the tie wire. Two methods of tying the tie wire were used, one called the "cross tie," and the other called the "standard tie." A special pin was machined from cold rolled steel for testing purposes to avoid breaking wooden pins. A lead thread cast on the end was compressed when a pull of 1,600 lb. was reached. Babbitt metal was used without any compression up to 2,400 lb. pull on the insulator. All ties were made with pliers by linemen from the San Francisco distribution department in the manner ordinarily found in line work on 11-kv. lines.

Test No. 1.

Conductor—No. 4/0 medium hard drawn weather proof.
Tie wire—No. 4 medium hard drawn weather proof (not annealed).

Test	Standard Tie	Cross Tie lb.
A	375 lb.	450 lb.
B	650 lb.	450 lb.
C	400 lb.	Wood pin broke.
D	300 lb.	615 lb.
E	550 lb.	Wood pin broke.
F	625 lb.	650 lb.
Average	483 lb.	380 lb.
	Average	509 lb.

Test No. 2.

Conductor—No. 4/0 medium hard drawn weather proof.
Tie Wire—No. 4 Annealed (bare).

Five tests were made, the pull on the conductors being as high as 2,000 lb., but the conductor would not slip through the ties. One cross-arm split through the center during this test.

Test No. 3.

Conductor—No. 6 medium hard drawn (bare).
Tie wire—No. 6 Annealed (bare).
Conductors at 250 lb. tension when the ties were made.
Cross Tie (Average of 7 or 8 times around conductor).

Test	Slip Pull	
A	775 lb.	Conductor pulled through tie.
B	825 lb.	Tie wire broke.
C	800 lb.	Conductor pulled through tie.
Average	800 lb.	

Test Standard Tie (2 back turns—8 turns of tie wire around conductor).

A	1,050 lb.	Conductor broke
B	925 lb.	Conductor would not slip.
Average	987 lb.	

1 back turn.

C	500 lb.	Conductor slipped through tie.
D	750 lb.	Conductor slipped through tie.
Average	625 lb.	

Test. No. 4.

Conductor—No. 4 medium hard drawn (bare)
Tie Wire—No. 6 Annealed (bare)

Test	Cross Tie (8 turns of tie around conductor)	
A	1,100 lb.	Conductor would not slip.
B	2,400 lb.	Conductor sheared at dynamometer.
B Additional tests		Conductor sheared at dynamometer

Test Standard Tie (1 back turn—8 turns of tie wire around conductor.)

C	1,000 lb.	Tie wire broke.
D	2,000 lb.	Conductor sheared at dynamometer.
Additional tests		Conductor sheared at dynamometer.

Tests on Steel Poles

In order to avoid any unnecessary testing work, the sub-committee next proceeded to assemble all data on recent tests or studies of steel and wood poles. The records of the Pacific Coast Steel Company showed that four tests had been made at their plant and one test had been reported by the Turlock Irrigation District. These tests were as follows:

Tests of Latticed Steel Poles

Test No. 1—Feb. 16, 1921.

Length—70 ft. Cross-arm—4 ft. Width at bottom 18 in.; 2½ in. x 2½ in. x $\frac{5}{16}$ in. legs at bottom—1¼ in. x ⅛ in. single lacing—½ in. bolts. The lacing of this pole was rather steep, being about 30 deg. from the vertical. For the test, two legs on one side of the pole were bolted to the tower testing frame, but the other two legs to parallel horizontal angles arranged for the purpose, which deflected under load to such an extent as to raise a question as to some of the conclusions.

The pole was very flexible, the pulling tackle being pulled to two blocks before critical load on cross-arm could be reached. 600 lb. at the end of a 4-ft. cross-arm gave a deflection of 5 ft. 4 in. On release of load, pole returned to within one ft. of original position. Torsion of arm relative to center line of pole at bottom was about one foot. Later a breast pull of 1,200 lb. sheared a bolt at the bottom connection to frame but did not injure the pole itself. These test loads were applied 63 ft. above the foundations.

The weight of this pole exclusive of cross-arms was 1,300 lb.

Test No. 2—Feb. 18, 1922.

Standard S-24 pole. Length 60 ft. Cross-arms 5 ft. 6 in.—made of 1¾ in. x 1¾ in. x ⅜ in. angles. Width at bottom 24 in. at top 12 in.; legs 2¼ in. x 2¼ in. x $\frac{5}{16}$ in.—2½ in. x 2½ in. x ⅜ in.—2¼ in. x 2¼ in. —⅜ in.—stubs 2½ in. x 2½ in. x $\frac{5}{16}$ in. lacing in pole 1¼ in. x 1¼ in. x ⅛ in.—single; lacing in stubs 1½ in. x 1½ in. x ⅛ in.—double. $\frac{7}{16}$ in. rivets. Weight of pole exclusive of cross-arms, 1236 lb.

This pole was set in earth, but the ground was soft and muddy owing to recent rains and newness of backfill. Load was applied at end of top cross-arm 5 ft. 6 in. from center of pole. The cross-arm failed on its compression side at a load of 1,350 lb. A breast pull was then applied to the pole, and was raised to 1,850 lb. when failure occurred in the legs at the ground line. This can be attributed in part to the condition of the ground, which was quite soft. A re-design of this portion of the pole should be made, as failure at this load might have been prevented by having additional steel to take the earth reaction.

Test No. 3—July 14, 1922.

Standard pole S-24. Same pole as test No. 2 but with base section set in concrete. Load was applied at end of 5 ft. 6 in. cross-arm. The loads with the corresponding deflections are as given in the following table:

Dynamometer reading	Deflection	Tangent of Angle of Twist at Cross-arm (approximate)
1,000 lb.	4⅝ in.	4/75
1,500 lb.	9 in.	8/75
1,800 lb.	11⅝ in.	11/75
2,000 lb.	15⅝ in.	15/75
2,250 lb.	Pole failed	

Load applied at end of center cross-arm. Failure by buckling of compression legs above first splice.

Test No. 4—June 21 and 22, 1923.

Southern Sierras Power Company 40-ft. pole. 24 in. square at ground line; 15 in. square at top. Legs 2 in. x 2 in. x $\frac{5}{16}$ in. and 2 in. x 2 in. x ¼ in.; lacing 1¼ in. x 1¼ in. x ⅛ in.—one 9 ft.-0 in. pipe cross-arm at top. Torsion test 1,000 lb. at top of insulator pin, 4 ft.-6 in. from center of pole.

The weight of this pole exclusive of cross-arms was 750 lb. The pole was first tested up to test load of 1,000 lb. without horizontal cross-bracing at top, with load increments of 250 lb. Distortion in the square cross-section of the pole occurred, due to absence of cross-bracing. The following day, with cross-bracing in place, pole was tested up to test load of 1,000 lb., with a deflection at end of cross-arm of 15 deg. No failure. Then pole was loaded up to 1,700 lb. at which point failure occurred in the attachments used to join pole to special concrete footing which was not a part of the pole. No failure occurred in the pole itself.

Breast Pull Test. 2,000 lb. at top of pole at center.

A pole with special tapered footing was set in new earth foundation. Loaded in 500 lb. increments, up to test load of 2,000 lb. with no failure. Pole was then loaded up to 2,600 lb. at which point failure occurred in an open hole in leg at ground line. No failure of any kind in the footing.

Test No. 5.

Made by Turlock Irrigation District on 60-ft., 66-kv., two-circuit pole. This pole was designed to take three broken wires, i.e., a test load of 1,420 lb. on each of three cross-arms on one side of the pole, 4 ft. from the center line plus wind on wires and pole. The weight of this pole exclusive of cross-arms was 2,214 lb.

The following is a quotation from a letter of R. W. Shoemaker dated Nov. 24, 1922:

"Might further advise that I tested one of these poles which was erected on a foundation I consider the poorest of the entire lot, first placing a horizontal pull of 3,000 lb. in the center of the pole at the height of the middle cross-arm; the deflection of the pole was a little over .3 ft. The same load placed at the end of the middle cross-arm did not increase the deflection of the end of the lower cross-arm more than .015 ft. with this torsional load. After relieving the load the pole went back to within .01 ft. of its original position. There was no evidence of cracking of the concrete base, but the base as a whole moved very slightly toward the compression side. The pole did not show the slightest sign of distress, and our figures lead us to believe that it will stand probably 8,000 lb. pull applied to the center of the pole at the middle cross-arm."

In view of the fact that all of these tests had been made simply by increasing the load and measuring deflections until the pole failed, it was felt that a new series of tests was required. Furthermore, no tests of wood poles were found.

Description of New Tests

The new tests were accordingly made on March 10 and 11, 1924, at the testing rack of the Pacific Coast Steel Company, this company and the Pacific Gas and Electric Company cooperating in doing the work.

In all, five poles were tested, two of the poles being wood poles set in earth and three being steel poles. Two of these steel poles were identical, the third was a trifle lighter. One of the heavier poles was set in concrete, the others were set in earth and a special tapered earth footing was used.

These poles were tested by applying loads at the top and measuring the load and deflection at intervals of 100 or 200 lb., as was thought best at the time. After each load was applied and deflection read, the load was released and deflection again read so that the elastic deflection of the pole could be determined.

Deflections at the ground line were also read, as there was considerable movement in the earth and it was thought that these measurements might be helpful. The condition of the ground where the poles were set was not very satisfactory as the ground was wet and spongy, particularly at the top. In backfilling the holes, as much dry material and rocks of various sizes were used as could be found nearby. The use of these rocks was responsible for the failure of the steel footings, as they caused concentrated reactions against the steel angles and produced local deflections, causing the failure of the poles.

The results of these five tests are given in the accompanying tables.

These data were studied rather hastily but the following conclusions from the tests were drawn:

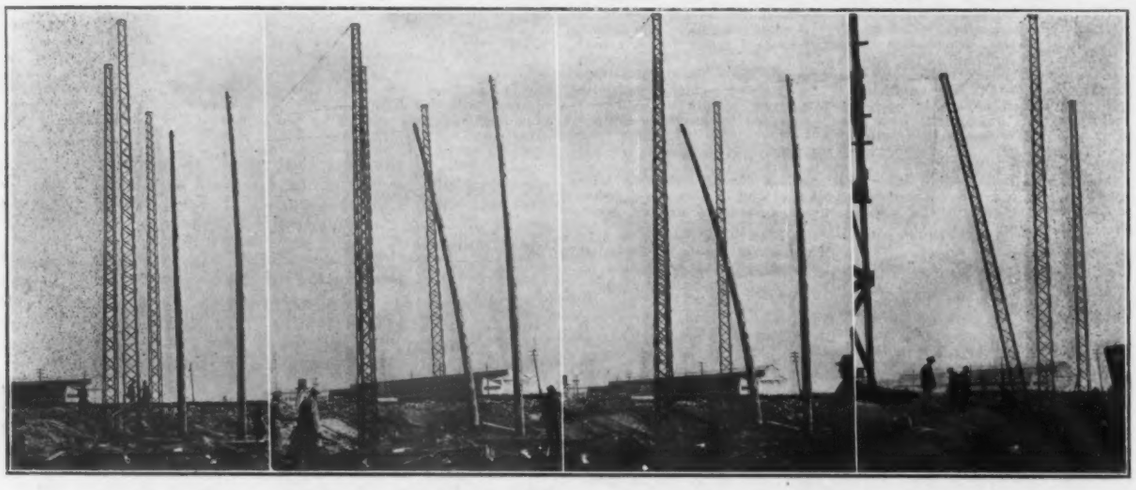
Analysis of Tests with Regard to Strength and Elasticity

A properly seasoned wood pole is almost perfectly elastic within the limits of the ordinary working loads. The two wood poles tested showed about twenty per cent difference in deflections for the same loads. The wood poles deflected approximately two and one-half times as much as the steel poles for the same loads. The two wood poles tested showed considerable variation in ultimate strength (3,500 lb. in one case against 2,800 lb.), although the diameters of the poles where the breaks occurred were practically the same. One had a 9-in. top, the other an 8-in. top.

TEST No. 1

60 ft. Wood pole set 8 ft. in ground.
8 in. top, 15½ in. diameter at ground line.
Pole failed 5 ft. 6 in. above ground—diameter 15½ in.
Load applied 51 ft. 6 in. above ground.

Load (Lb.)	Deflection at Ground Line (In.) Load on	Load Released	Deflection of Top of Pole (In.) Load on	Load Released	Remarks
0	0	0	.....	....	
100	0	0	0	....	
200	0	0	3½	....	
300	0	0	6½	½	
400	1/16	0	9½	1	
500	⅛	0	13¼	2½	
600	3/16	3/16	18¼	4¼	
700	¼	⅛	23	7	
800	5/16	1/16	28¾	9½	
900	⅜	⅜	33½	11½	
1,000	7/16	1/16	39½	14½	
1,100	⅛	7/16	46	17	
1,200	1	⅛	51½	17¾	
1,300	1 1/16	7/16	56½	19	
1,400	1⅛	1	61½	20¾	
1,500	1 3/16	1 1/16	65¼	21½	
1,600	1 7/16	1¼	71½	23¾	
1,700	1 7/16	1 3/16	77	24½	
1,800	2	1⅜	81½	27½	
1,900	2 1/16	1 7/16	86¼	28¼	
2,000	2½	1 7/16	92¾	29	
2,100	2 5/16	2¼	98	66	Load backed off to 1,000 lb.
2,200	2 7/16	2½	101½	71	Load backed off to 1,100 lb.
2,300	2 7/8	2 5/16	105½	73½	Load backed off to 1,200 lb.
2,400	3	.....	112	....	
2,500	3 1/16	.....	116½	....	
2,600	3¼	.....	121	....	
2,700	3 3/16	.....	126	....	
2,800	3 3/4	.....	132½	....	
2,900	3 7/8	.....	138	....	
3,000	4	.....	142	....	
3,100	4 1/4	.....	149½	....	
3,200	4½	.....	156½	....	
3,300	4 3/4	.....	163½	....	
3,400	5	.....	172½	....	
3,500	6	.....	.....	....	Pole failed.



Poles under test at plant of Pacific Coast Steel Company, South San Francisco. At the left is a view of the poles before the tests; next shows 2,000 lb. on wood pole; next, 3,000 lb. on wood pole and the last 1,400 lb. on steel pole.

TEST No. 2

60 ft. Steel pole set in earth.
Depth of setting, 7 ft. 6 in.
Weight of pole, 1,190 lb.
Load applied 52 ft. 6 in. above ground.
Dimensions—1 ft. 10 in. sq. at ground line; 15 in. sq. at top.

Load (Lb.)	Deflection at Ground Line (In.) Load on	Load Released	Deflection of Top of Pole (In.) Load on	Load Released	Remarks
150	....	....	....	....	
400	3/16	1/16	11	8 1/2	
600	1/8	3/16	21	17	
800	1/8	1/16	36	28	
1,000	1 1/2	1 1/16	49	39	
1,200	2 1/8	2	65	51	
1,400	2 3/4	2 1/2	84 1/2	68	
1,400	3 1/2	3 1/8	....	....	Failed

TABLE D

TEST No. 3

60 ft. Steel pole set in concrete.
Dimensions of pole same as No. 2.
Concrete foundation 2 ft. 8 in. square by 7 ft. 0 in. deep.
Pole failed at connection to stubs on compression side.

Load (Lb.)	Deflection of Ground Line (In.) Load on	Load Released	Deflection of Top of Pole (In.) Load on	Load Released	Remarks
0	....	....	....	....	
500	....	....	3	1/4	
700	....	....	6 1/2	1/2	
900	....	....	9 3/4	1 1/2	
1,100	....	....	13 1/2	3	
1,300	....	....	17 1/4	4	
1,500	....	....	22 1/4	6	
1,700	....	....	26 1/2	8	
1,900	....	....	32	....	Failed

TABLE E

TEST No. 4

60 ft. Steel pole set in earth.
Dimensions same as No. 2 and No. 3. Weight of pole 1,100 lb.

Load (Lb.)	Deflection at Ground Line (In.) Load on	Load Released	Deflection of Top of Pole (In.) Load on	Load Released	Remarks
0	0	0	....	....	
400	1/8	1/8	2	1	
600	1 1/4	1 1/4	22	16 1/2	
800	2 1/4	2 1/8	41	31	
1,000	3	2 3/4	56	43	
1,200	4 1/4	0	76 1/2	59	
1,300	5 3/8	....	118	....	Discontinued owing to incipient bending of horizontal angle at ground line.

TABLE F

TEST No. 5

60 ft. Wood pole set 8 ft. in earth.
Tip diameter 9 in.—Butt diameter 15¼ in.
Pole failed 6 ft. 6 in. above ground at point having diameter of 15¼ in.

Load (Lb.)	Deflection at Ground Line (In.) Load on	Load Released	Deflection of Top of Pole (In.) Load on	Load Released	Remarks
0	...	...	....	....	
400	1/8	1/8	9	0	
600	1/2	3/8	19¼	3	
800	7/8	5/8	28	10½	
1,000	1¼	7/8	40¼	9	
1,200	1¾	1¾	54½	14	
1,400	2¼	2	65½	17¼	
1,600	2¾	2¼	77½	21	
1,800	3¼	2½	88	23	
2,000	3⅝	3	101	35	
2,200	4½	3½	114½	42	
2,400	4¾	3¾	127½	47	
2,600	5¼	4	146	49	
2,800	5¾	...	161	....	Failed

The two heavier steel poles tested showed almost exactly the same elastic deflections for the same loads, although one was set in earth and one in concrete. The lighter steel pole showed twenty-five to thirty per cent more deflection.

On the basis of General Order No. 64 of the California Railroad Commission, the steel poles tested were about 1.5 stronger than the stronger of the two wood poles, i.e., they could be used in a line to carry loads 1.5 greater. This is on account of the different safety factor permissible because of the deterioration of wood. The steel pole tested is heavy enough to carry one broken wire with safety. A steel pole may, and the steel pole tested in earth did, give in the earth so that the total deflections were as much as or greater than those for the wood poles, but bending in the steel itself was of course less.

In the above tests of steel poles, failure occurred in the earth footings and not in the poles themselves. This footing should be redesigned and further experiments carried on. It is, of course, easy to build an earth footing heavy enough to stand without question, but in this case an attempt was made to have it as light as possible. However, the above tests were made to study the characteristics of the poles rather than of the footings.

Relative Costs of Wood and Steel Poles

The following table shows approximate relative first cost and annual costs of wood and steel poles for use on 60-kv. lines. It is based on the use of double circuit poles, pin type insulators, and a hole digging machine for digging holes and erecting poles. A life of twenty years is allowed for the butt treated poles, twenty years for insulators and forty years for steel poles.

The "heavy duty pole" is one which has been tentatively designed by the Pacific Gas and Electric Company for a double circuit wood pole line replacement, using 400-ft. spacing of poles. The pole is designed to resist the breakage or slipping through the ties at 1,000 lb. per wire for the three wires of one circuit. This pole has not been used, and it is only included in this report to bring out the fact that if heavier duty is expected of steel poles than of wood poles, steel poles cannot compete on the basis of annual cost alone. Consideration must be given to other factors, such as the greater mechanical stability, freedom from termite attack, etc.

The "light duty pole" used is the type S-24 pole of the Pacific Coast Steel Company modified to take care of the weakness in the footings which developed at the pole test. This pole will have about 50 per cent more strength than a wood pole, when due allowance is made for the difference in safety factors required by General Order 64. This pole, as is evidenced by the table of costs, is on an even basis of annual cost when the spans are increased in the rates shown in the table, namely, 40 per cent for steel poles set in earth and 63 per cent for steel poles set in concrete.

If the length of life of a wood pole is less than twenty years, or the life of a steel pole more than forty years, the ratios above would, of course, be altered. In fact, if the life of a wood pole were only ten years it becomes economical to install steel, pole for pole, without increasing spans.

Report of Sub-Committee on Aerial Cable Construction

By T. W. SNELL*

THIS sub-committee has endeavored to investigate the relative merits of various types of insulation for overhead conductors and to obtain comparative costs of several types of construction designed to obviate trouble from accidental "grounds" or "shorts" caused by trees in the line. The work of the sub-committee has been done principally by correspondence, augmented by discussions at the committee meetings of the Technical Sections and a few independent experiments.

*Sub-Committee on Aerial Cable Construction: T. W. Snell, chairman.

ESTIMATED RELATIVE CONSTRUCTION COSTS OF TWO CIRCUIT WOOD AND STEEL POLES
NO OVERHEAD INCLUDED

Item	Wood Poles 50 Ft.	Wood Poles 60 Ft.	Light Duty 60-Ft. Steel Poles In Earth	Light Duty 60-Ft. Steel Poles In Concrete	Heavy Duty Steel Pole in Concrete
Wood pole (including arms)	$30.00	$ 36.00	.....	.....	.....
Steel pole (including arms)	.....	.....	$ 87.00	$ 81.00	$132.00
Hauling and handling	3.00	3.00	3.00	3.00	3.00
Dipping stub	.....	.....	1.00	.....	.....
Digging holes	4.00	4.00	4.00	5.00	9.00
Erection and setting	12.00	12.00	12.00	12.00	12.00
Concrete	.....	.....	.....	34.00	45.00
Total cost of pole	$49.00	$ 55.00	$107.00	$135.00	$201.00
Insulators for 60-kv. (pin type including hardware at $7.50 each)	$45.00	$ 45.00	$ 45.00	$ 45.00	$ 45.00
Total cost of pole and insulators	$94.00	$100.00	$152.00	$180.00	$246.00
Interest at 8%	$ 7.50	$ 8.00	$ 12.20	$ 14.40	$ 19.70
Sinking Fund at 5%					
20 years for wood pole (3.03%)	1.50	1.67	.....	.....	.....
20 years for insulators (3.03%)	1.36	1.36	1.36	1.36	1.36
40 years for steel pole (0.83%)	.....	.....	0.89	1.12	1.67
Annual cost per structure	$10.36	$ 11.03	$ 14.45	$ 16.88	$ 22.73
Ratio of spans required for equal annual cost	1.00	.....	1.39	1.63	2.19
Span	260	.....	360	425	570*

*Heavy duty pole on which cost data is based was designed for 400-ft. span and would not give sufficient clearance for 570-ft. span.

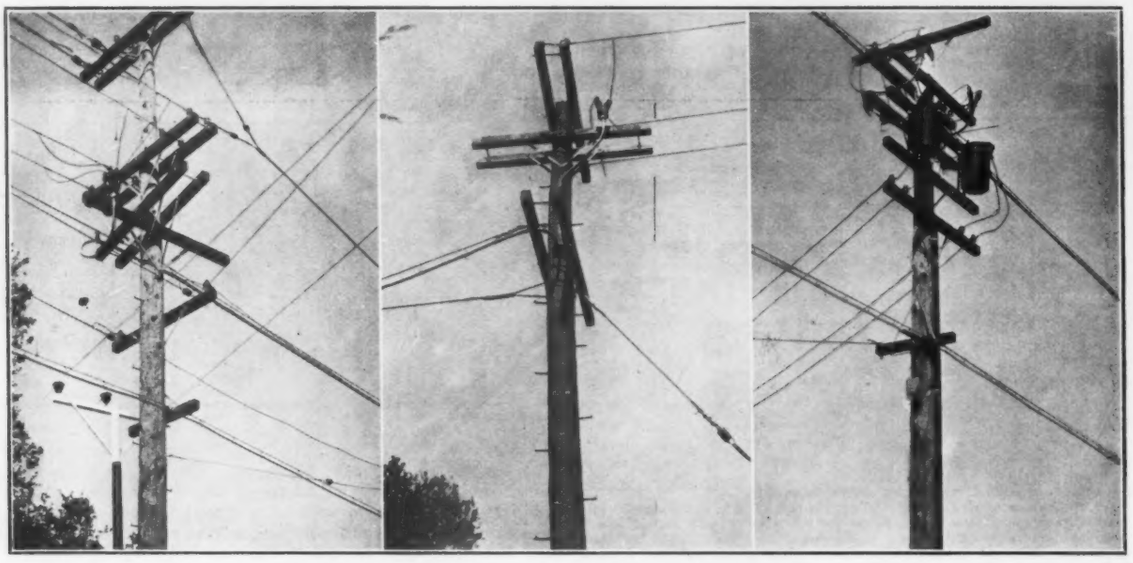


Fig. 1 (left), Fig. 2 (right) and Fig. 3 (center).—Showing from left to right typical dead end of four-conductor cable terminal; cable dead end; and four-conductor cable on 2-phase system with two-conductor cable taken out of splice with connection to two 2,300-volt transformers.

Weatherproof insulation, rubber covering, fabric covering and any combinations of such coverings are subject to damage during installation and to a variable amount of depreciation from age and exposure. For this reason the committee does not intend that any part of this report should be construed as a recommendation for absolute reliance on any such insulations, particularly where human safety is concerned.

Weatherproof Insulation

This type of covering has been generally considered as of very little value except on secondary voltages. When new and undamaged, the insulating value is usually sufficient to withstand at least 2,300 volts. Frequently the insulating value decreases very rapidly and after five or six years is so low in spots that when any appreciable area is subjected to a differential of 2,300 volts a breakdown is almost certain to occur. This is particularly true when moisture is present, as, after the compound is cracked, the only insulating value is the mechanical separation afforded by the layer of compound between the conductor and the object with which it may be in contact.

Several series of tests on old weatherproof wire have been made recently. Samples of wire which had been in service under severe conditions for ten to twenty years have successfully withstood 2,300 volt tests. In samples of other wire which had been in service for a lesser period under the same conditions the insulating value was found to have been entirely destroyed. The results of these tests lead to the conclusion that weatherproof insulation of specifications suitable to the climatic conditions under which the line operates, may retain a considerable part of its insulating qualities for twenty years or more. If this life can be obtained, the cost of weatherproof insulation may be justified in many cases, as a partial protection against "swinging shorts" during storms or during construction and against accidental "grounds" in light trees.

The failure of weatherproof insulation is mechanical. The insulating compound is cracked by abrupt bending, or very sudden changes of temperature; moisture penetrates to the wire through strands of braid which have been insufficiently impregnated; or the insulation may be partially or entirely removed through abrasion or by melting of compound. The wire should be installed carefully, exercising reasonable care to prevent abrupt bending or abrasions when dragging over cross-arms.

Triple braid insulation increases the safety factor by increasing the thickness of the compound and lessening the possibility of surface cracks extending to the conductor. Cotton braid is said to have a longer life than jute and is less liable to absorb moisture as the impregnation is more thorough.

There is a constant tendency for the compound to flow from the upper to the lower side of the wire. It is not necessary for the compound to melt and drip in order to have the flow take place. A very slight softening will cause a gradual bow, which over a period of years will expose the braid on the upper side of the wire. The braid will then disintegrate very rapidly, allowing the insulation to hang in shreds. Various Pacific Coast companies specify that the compound shall not become soft at temperatures ranging from 120 deg. to 130 deg. F. As the temperature of the wire may be considerably higher than the recorded atmospheric temperature, it is possible that a higher softening point would add materially to the life of the insulation.

Weatherproof insulation is worn off very rapidly by abrasion and to protect against this, circular loom has sometimes been placed over wires passing through trees. This adds very little to the weight of the wire, it presents a tough surface for contact with trees and at the same time preserves the insulating qualities of the weatherproofing by protecting it from the elements.

Tree Wire

Wire insulated with rubber, or varnished cambric, or both, covered with circular loom and with an outer cover of weatherproof insulation, has been widely and successfully used on lines up to 4,000 volts, passing through light trees. For higher voltages any type of insulation exposed to the weather has a very doubtful value.

It is sometimes impossible to obtain lateral space through ornamental trees for wires suspended in the usual manner on cross-arms, and there is danger of the wires being broken by large falling branches. To reduce the required lateral space, a three-conductor tree wire has been used, but it has not yet been in service a sufficient length of time to determine its probable life. In order to provide additional mechanical strength, as well as reducing the space required, the several tree wires comprising a circuit, have been bunched together and suspended from a messenger by marlin. In one recent installation the wires have been attached to the messenger with cable rings. With either method of suspension the wires may be fanned out on a cross-arm at each pole so that branch lines or transformers may be readily attached. The permanency of this type of construction under the severe strain of primary voltages and weather exposure has not been determined, but lower-voltage tree wire suspended in this manner for secondary circuits, may materially assist in maintaining service in heavily wooded districts.

Aerial Cable

About twenty-five miles of lead covered aerial power cable for voltages from 2,300 to 11,000 volts is in use in California. Much of this cable has been installed,

where tree wire with open cross-arm construction had been formerly used, and has proved more satisfactory than the tree wire. Large falling limbs are ordinarily deflected with no damage to the cable. In several instances, trees have fallen directly across the cable, breaking the cross-arms on several adjacent poles, but not damaging the cable or interrupting service. Cables have been operated without failure for over fifteen years in a heavily wooded territory, where falling limbs and trees have blown onto the line during every heavy storm.

The cable is installed in the same manner as telephone cable, except for insulation and clearances as provided in General Order No. 64 of the California Railroad Commission.

The cable and supporting messenger must be kept away a minimum distance of 15 in. or 18 in. from the center line of the pole, depending on the voltage. It is recommended that this distance be increased wherever practicable, bearing in mind that this increase of distance adds extra strain to the cross-arm and the bracing must be increased accordingly.

In making a dead-end it is advisable to carry the messenger one span beyond the cable terminal, dead-end on the pole center and attach the messenger to a grounded anchor guy. If this dead-end pole carries supply conductors both the messenger and the anchor guy should be attached not less than 8 ft. below the nearest conductor. When necessary to carry the cable terminal or a tap from the cable to an arm above the messenger, the vertical run should be kept entirely outside of the climbing space, preferably near the outer end of the cross-arms. (See Fig. 1.)

If the messenger or cable is brought within the climbing space or the required distance from pole center (except on dead-ends 8 ft. below conductors) the messenger must be effectively insulated at a point outside of the climbing space and the cable must be insulated with the equivalent in insulating and mechanical strength of 1½ in. of wood. Fig. 2 shows this type of installation in which the vertical run is carried up the pole, enclosed in a protective moulding.

Because of the hazard always present when a ground is maintained within reach of a man working on energized conductors, too much stress cannot be laid on the necessity of protecting such a man from accidental contact with the grounded messenger or cable sheath.

For cables of three No. 2 or smaller conductors, a pole spacing of 140 to 150 ft., using a ⅜ in. messenger is satisfactory. Larger cables require a closer pole spacing in order to reduce the sag, and maintain a neat appearing line. High-strength, 7/16 in. stranded messenger is sufficient for three conductor 4/0-11,000 volt cables. Any cable suitable for underground work may be used. Both rubber and paper insulated cables are used extensively. The lead sheath of cable should be permanently bonded to the messenger, and the messenger should be permanently grounded.

In 4,000 volt systems a four-conductor cable is often used so that the neutral wire is carried within the cable. An open wire neutral carried on the cross-arm is very satisfactory but it is advisable to place a permanent ground at each end of the tree exposure to prevent an open neutral, in case the conductor is broken by falling trees or limbs. Where a cable is subjected to abrasion by trees, it may be protected by wooden moulding 1½ in. to 2 in. thick. Discarded automobile casings have been used for this purpose. Their light weight is an advantage over wooden moulding.

Potheads should be installed at all probable tap off points, or transfer locations, at the time the cable is installed, as later installations will require a shut down of 6 to 8 hours for each pothead. Three phase potheads are very satisfactory on cables up to 4,000 volts. Fig. 3 shows this. To prevent short circuits by birds or accumulation of wet leaves, three single potheads should be used for higher voltages.

Due to its lower maintenance cost, higher and more reliable insulating qualities and lower susceptibility to failure, the additional cost of lead covered aerial cable over that of tree wire is often justified. Underground construction may be somewhat less liable to failures than aerial cable, but the aerial cable has been so very satisfactory that the underground expense for protection from trees does not seem warranted, particularly in districts where a complete underground system is not desirable in the near future.

Report of Sub-Committee on Line Switches, Fuses and Protective Devices

By R. E. CUNNINGHAM*

THERE have been but few new developments in the past year in line switches or protective devices. There are, however, several types of equipment which it is well to mention for the information of members companies who as yet have not tried out this apparatus which others have found successful.

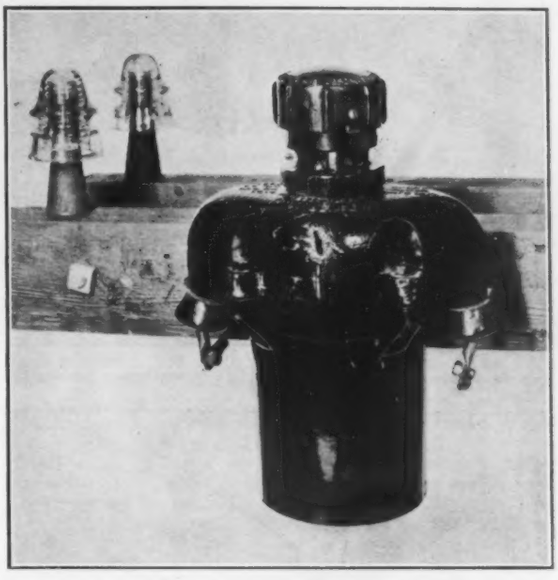


Fig. 1.—D & W oil fuse cutout on overhead line.

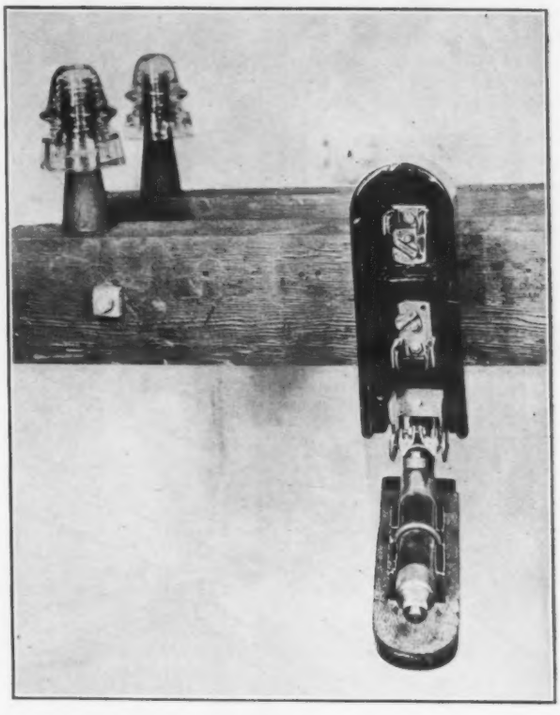


Fig. 2.—Throttle fuse for 2,300 and 4,000-volt lines.

Several companies report very successful use of D. & W. oil fuse cutouts on overhead lines where heavy

*Sub-Committee on Line Switches, Fuses and Protective Devices: R. E. Cunningham, chairman.

Fig. 3.—Simple fuse mounting for 11-kv. transformer installation.

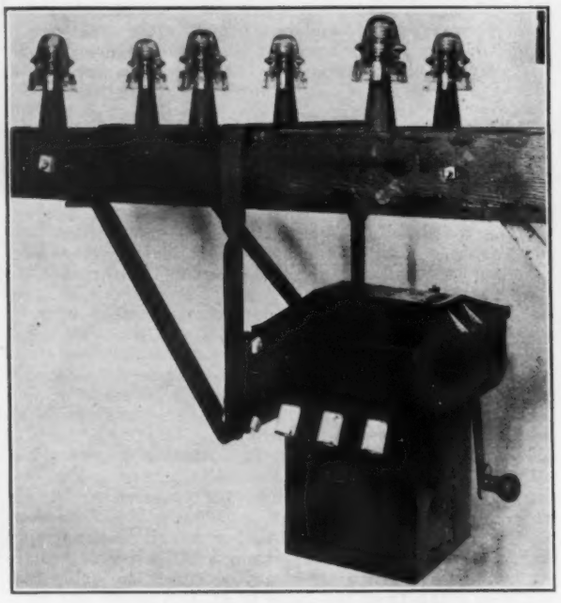


Fig. 5.—Three-pole oil switch for 2,300-volt lines.

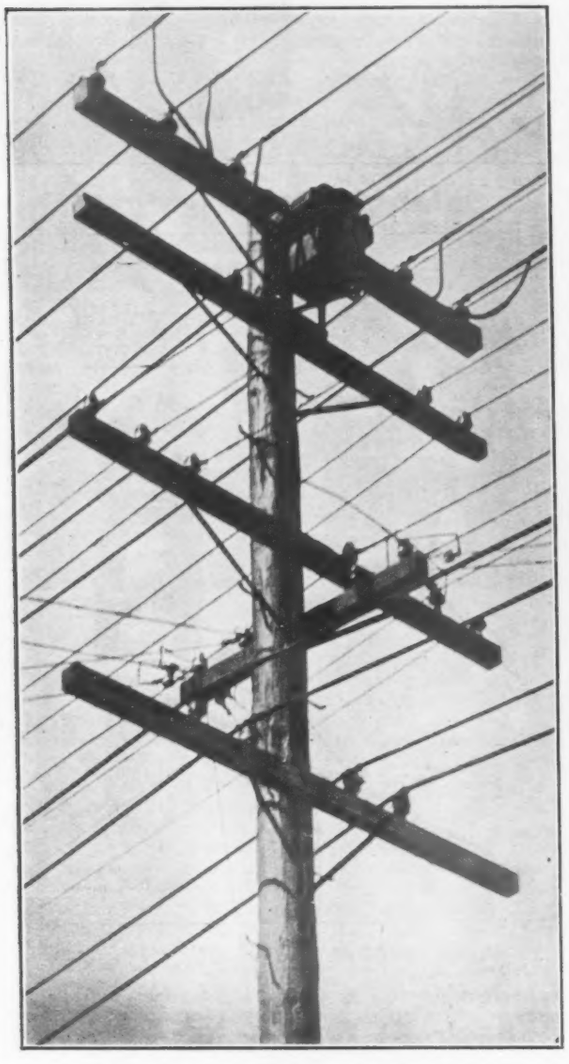


Fig. 4.—T.P.S.T. three-pole oil switch for paralleling 4,000-volt feeders.

capacity is required. These fuses are already well known as they have had extensive use in the underground and indoor installations. (See Fig. 1.)

The Throttle Fuse is a newer development in the 2,300-4,000 volt class that has been used quite successfully on overhead lines where a greater rupturing capacity is needed than the usual insulator type of fuse block. (See Fig. 2.)

Fig. 3 shows a simple fuse mounting quite extensively used, for 11-kv. transformer installations. The fuses are placed and removed by means of a wooden stick or fuse grabber. Both bakelite and porcelain fuse tubes are used.

Figs. 4 and 5 show the use of three pole oil switches on 2.3-kv. and 4-kv. lines for sectionalizing and paralleling purposes. These switches have been used for some time by several companies and are found to be quite satisfactory.

Fig. 6 shows an installation of high voltage three-

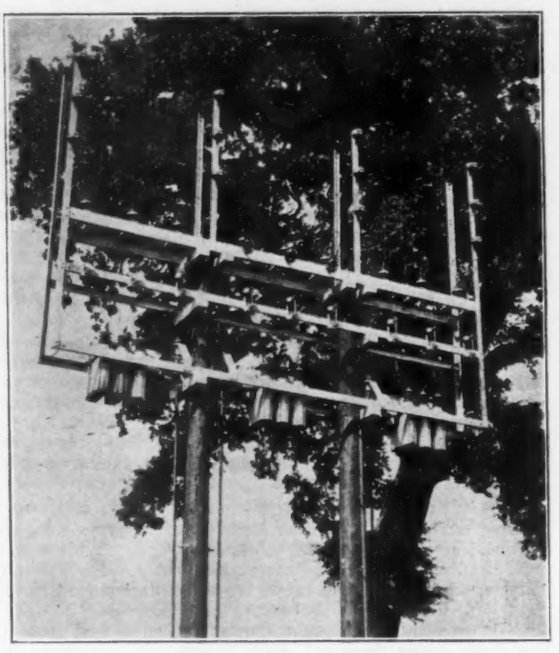


Fig. 6.—High voltage three tank switches for junction switching center on transformer installations.

tank switches for a junction switching center and for a transformer installation. These switches are reported to be very satisfactory and to have high rupturing capacity.

There has also been developed a double throw switch for use where double service is desired but conditions will not permit the two circuits to be paralleled.

There have been two new developments in lightning arresters for use on distribution lines. The Pellet type

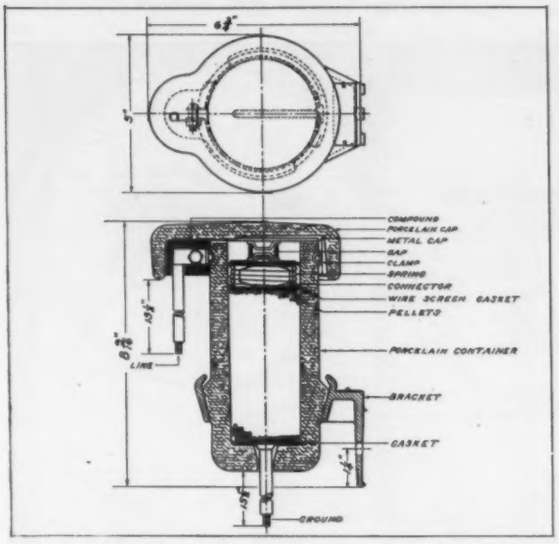


Fig. 7.—Pellet type lightning arrester for 2,300-volt lines.

is an adaption of the well known oxide film arrester. In external appearance it does not differ greatly from the old compression type arrester for 2,300-volt lines. It has a rugged porcelain body supported by a suitable bracket for attaching to cross-arm. In the top of the arrester there is a small gap, the upper electrode being connected with the line wire and the lower electrode in compression contact with the pellets which form the path to the ground. These pellets are of lead peroxide coated with insulating powder. The action of the arrester is very similar to the oxide film. This arrester is also made for other voltages up to 15,000 volts. (See Fig. 7.)

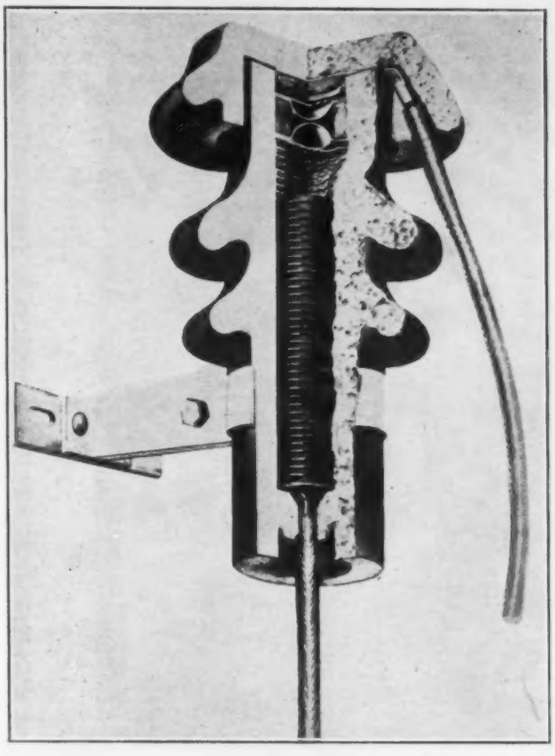


Fig. 8.—Auto valve lightning arrester for 2,300 to 15,000-volt service.

Another arrester that has been brought out is the auto valve. This arrester is made up of a series of carborundum discs separated by mica washers with a small sphere gap in the top. This arrester is made for low voltage or neutral arrester and for 2,300 volts up to 15,000-volt service. (See Fig. 8.)

Report of Sub-Committee on 4,000-Volt Overhead Distribution

By N. B. HINSON*

THE tremendous growth of the electrical load in the West, particularly in the small cities and communities of California, during the last five years has been so rapid that it has been difficult to keep up with the demands for electric energy. In certain agricultural and industrial districts, where the distribution voltage is 11 kv. or 16 kv., and the business taken on is in large units, additional feeders have in the past and will in the future be able to take care of the growth, but in a great deal of the territory where the distribution voltage is now 2,300 volts, and the character of the territory, the size of the individual loads, the cost of construction and the right of other utilities operating in the territory, make the use of 11 kv. or 16 kv. out of the question, the problem of taking care of the ever increasing load is a serious one. This latter territory includes practically all the cities and towns and a great many rural sections in which scattered lighting loads and small power loads have been connected to 2,300 volt lines.

In all this territory, the telephone and telegraph companies are in combination with thousands of power company poles and a voltage in excess of 5,000 volts would necessitate separate pole lines which would increase the cost of service and create considerable opposition, due to the presence of two pole lines instead of one. Also, the increased cost of higher voltage transformers for small loads, particularly lighting, would make it practically impossible to take on the many small consumers.

In the rural sections, where the long lines cause excessive drop, additional stations could be constructed, and in the congested city districts where lines are becoming overloaded, additional circuits or heavier copper could be installed. These methods mean the expenditure of large sums of money, and, in the congested districts, the installation of additional circuits means greatly added expense for the new positions, and in some cases, the complete re-arrangement of circuits and stations. This leads to the conclusion that the adoption of a higher voltage than 2,300 volts, which could be carried on the present wires, insulators and pole lines, with the minimum change of equipment, would be the solution of the problem. This leaves only two standard voltages available: 4,400 volts delta, or 4,000 volts star. If 4,400 volts delta is chosen, it would be necessary to change all the transformers on the lines, the station transformers, regulators and all other equipment designed for 2,300 volts. Also, all the old transformers coming in from the lines could not be used again. This would mean an enormous loss, when it is considered how many 2,300-volt transformers there are in service on any particular system.

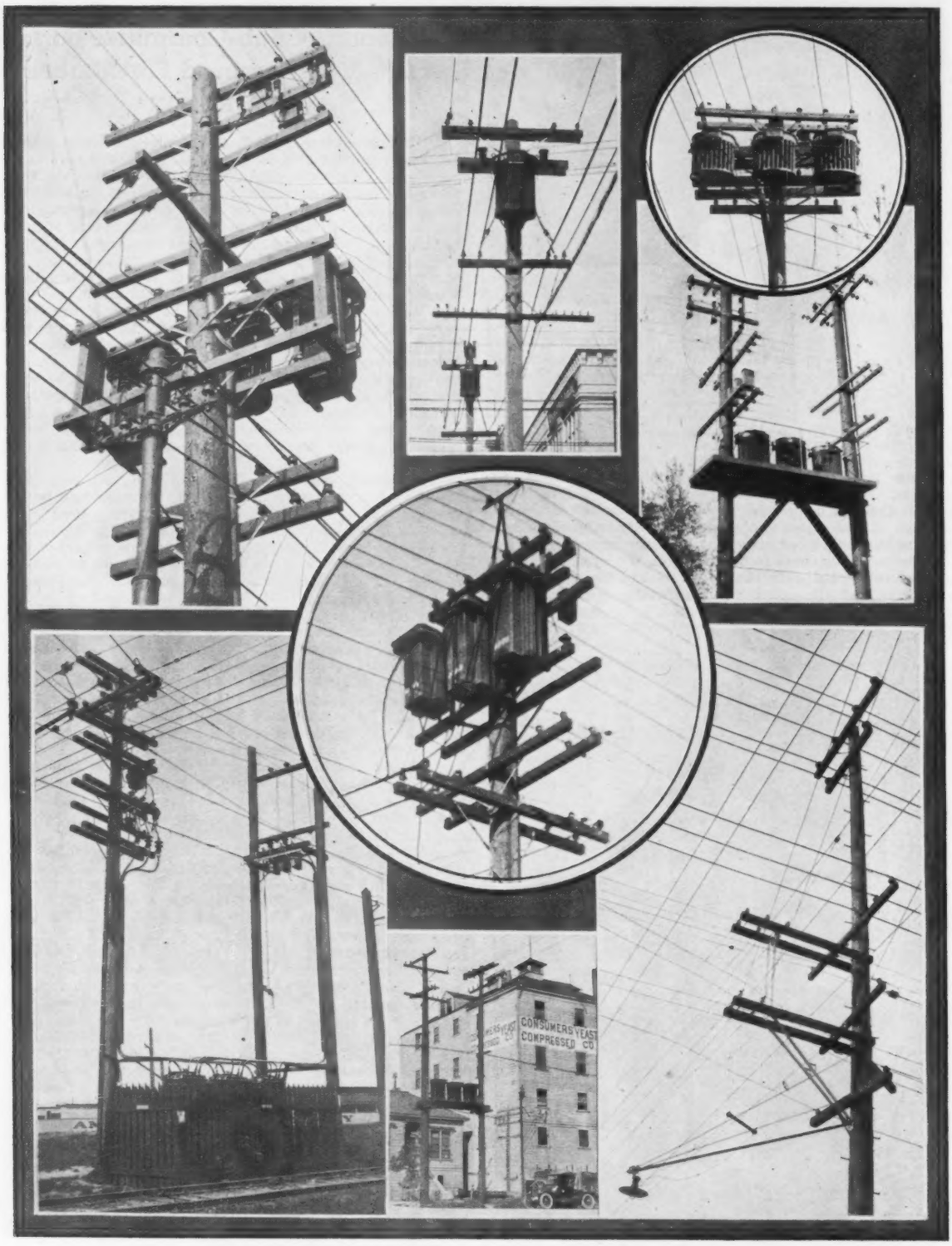
This leaves the 4,000-volt star connected system as the logical one to use, with the following advantages: The present station transformers can be used, connecting them star on the secondary side, instead of delta; the present line transformers can be used, re-connecting them star on the primary side for power and in the case of lighting transformers, by re-connecting them from one-phase wire to the neutral ground wire. The same wire, insulators, cutouts, and pole top switches can also be used. The station regulators will have to be changed where they are now three-phase 2,300 volts but single phase 2,300-volt regulators can

*Sub-Committee on 4,000-volt Overhead Distribution: N. B. Hinson, chairman; C. E. Young, R. B. Ayres, E. Y. Porter, G. M. Bowman, E. R. Northmore.

be used, three to each circuit. It is necessary to make some changes in current transformers, switches, etc., but the expense involved is not very great.

There are several methods of wiring that can be used on such a 4,000 volt system: first, three wire only with the neutral grounded at the station; second, four wire with the neutral grounded at the station only; third, four wire with the neutral grounded at the station and at all the large power banks and at numerous other points along the line. All three systems are in use on the Pacific Coast though the first is used as an extension of the four wire systems where the lighting load is very scattered and it has been cheaper to use special transformers for lighting rather than carry the neutral wire all the way through. This is not the case in small towns and cities where the lighting predominates. These special lighting transformers have a voltage rating of 4,000 volts to 115-230 volts in place of the standard 2,300 volts to 115-230 volts. These same transformers are also installed open delta for small power loads on the three wire 4,000-volt system.

The advantages of 4,000 volts as against 2,300 volts



Typical 4-kv. transformer installations.

are that in the congested districts where the circuits, switches and other equipment are loaded to their current carrying capacity, the capacity in kva. of the circuit can be increased by 75 per cent without any increase in current, and with this additional load, the per cent of voltage drop to the consumer, will be reduced to 57 per cent of that at 2,300 volts. In the sparsely settled territory where the equipment is not fully loaded in amperes, but the voltage drop is the limiting factor due to the long lines, by changing to 4,000 volts, the load can be increased by 200 per cent with no greater per cent drop, or the lines can be three times as long with the same load and no greater per cent drop, or with no increase in load, the per cent drop will be 33 per cent of that using 2,300 volts. The per cent energy loss with the same load at 4,000 volts, will be reduced to 33 per cent of that at 2,300 volts. The reduction in voltage drop increases the quality of the service, and the decrease in line loss increases the efficiency of the distribution system; two things that all operating companies are continually striving to attain.

A number of the operating companies in California are right now in the midst of a change over from 2,300 volts to 4,000 volts and several others are making plans for the change in the near future. Practically all are following the same general plan, and a brief description of the methods used, the transformer connections and the few points of difference may be of interest and help to other companies contemplating changing over in the near future.

First of all it is necessary to install the fourth wire which is the star neutral and ground wire. It has been thought advisable by some companies to identify this wire all the way throughout the system, and various methods have been used, such as a white insulator to support it, placing the wire in a special location, stenciling on the cross-arm a white "G" under the wire. The two are used on new work and the latter on old work when an old phase wire has been cut to the neutral ground.

The neutral wire is usually one size smaller than the phase wire as three No. 4 with No. 6 neutral, three No. 2 with No. 4 neutral, three No. 2/0 with No. 2 neutral, except when more than one feeder is run on the same pole line, when the neutral is the same size as the feeders, and is common to both. No wire smaller than No. 6 is used as the neutral.

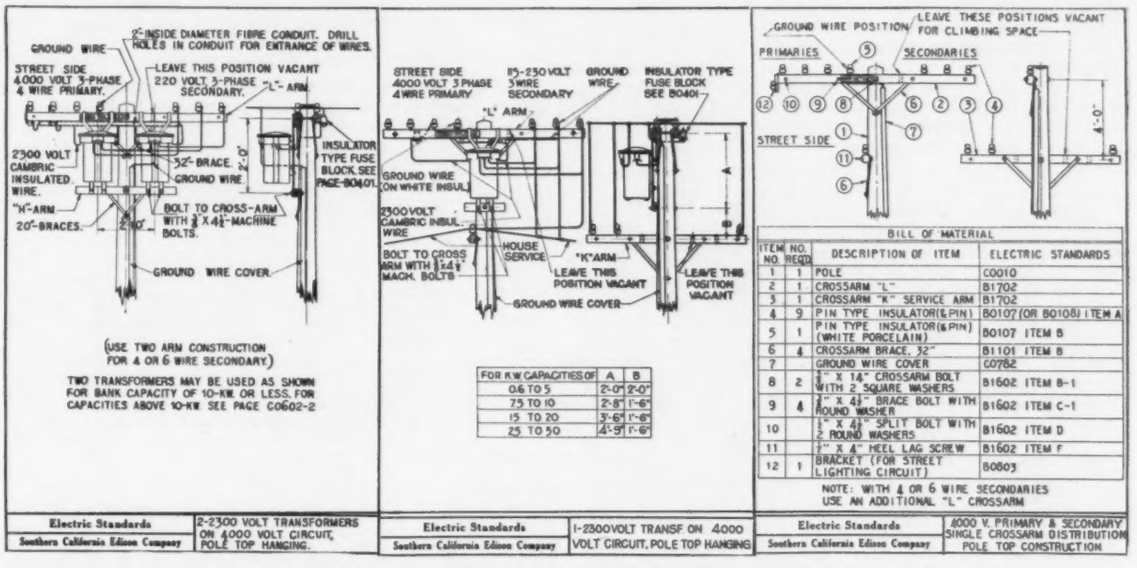
When the old circuit being changed over was a single phase lighting feeder two new wires were pulled in and connected to one of the present wires making three wires of the same polarity. The transformers were then reconnected leaving one terminal of each transformer still connected to one old wire and connecting the other terminals to the other three wires so that the load will be balanced when cut to four-wire 4 kv. When the main cut over was made it was only necessary to change the jumpers at the tie-in point and the system was operating. Some of the Eastern companies only use the four-wire system for the feeders from the station to the center of distribution, running single phase mains from this point. In scattered territory this is not much better than the 2,300 volt system as all the losses in the single phase lines are at 2,300 volts. Most California companies not only have the feeder four-wire but carry this system out on all the main branch circuits so that only the short side taps are on single phase or two phase wires and a neutral.

On three phase power or combined power and lighting circuits the change over is a more difficult undertaking, and requires more of an interruption to service. If the station has two or more banks of transformers and the load is such that during certain periods one bank can carry the load, the other bank can be cut to 4 kv. and one circuit cut over at a time. If there are two stations, one of which can carry the load while the other is changed over, or if an old sub or pole top is to be replaced with a new station, the new station can go on the line at four-kv. The use of one-to-one ratio transformers connected 2,300 volts delta to 4,000 volts star which can be moved from the outer end of the circuit toward the station and from circuit to circuit helps materially in cutting over.

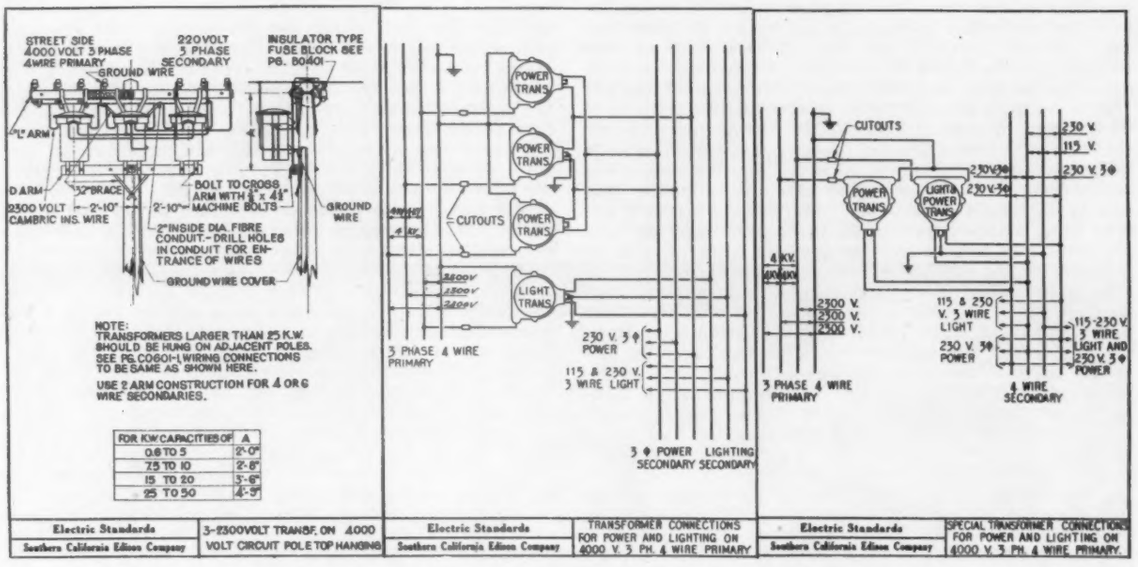
One of the difficulties to be overcome has been the old 2,300-volt motors that could not be cut over or replaced. These have been supplied by the use of three-phase auto transformers 4,000 volts to 2,300 volts.

Three phase 4,000-volt to 230-460-volt transformers have not been used extensively but are coming into use for power purposes in the east and one Pacific Coast company has started to use them in sizes from 10 kva. to 50 kva. The general practice is to use one primary cut out on lighting transformers tying the other side solid to the neutral ground wire. On open delta transformers two cut outs are used, one on each phase wire, tying the common point solid to the neutral ground wire. On open delta connection it is necessary to reverse the connection on one transformer, as compared to open delta connection on 2,300 volts. This can be done on the primary or secondary but if done on the primary it will not be necessary to make any changes in case a third transformer is installed later. Care should be taken to see that open delta loads on a three wire tap line consisting of neutral and two phase-wires are small, as the current in the neutral ground wire is 1.41 times that in either phase wire and the drop is at 2,300 volts between the neutral and each phase wire and the drop between the two phase-wires is at 4,000 volts so that the voltage unbalance may be very bad if the line is long and the load heavy. Some power companies limit the open delta power load on tap lines to 10 kw.

On three-transformer banks and three-phase transformer, three cut-outs are used, one on each phase-wire. Some companies connect the neutral of the three star-


2"-INSIDE DIAMETER FIBRE CONDUIT. DRILL HOLES IN CONDUIT FOR ENTRANCE OF WIRES.
GROUND WIRE
STREET SIDE 4000 VOLT 3-PHASE 4 WIRE PRIMARY.
LEAVE THIS POSITION VACANT 220 VOLT 3-PHASE SECONDARY.
"L" ARM
2300 VOLT CAMBRIC INSULATED WIRE.
52" BRACE
GROUND WIRE
INSULATOR 1 TYPE FUSE BLOCK, SEE PAGE B0401
"K" ARM
20" BRACES.
BOLT TO CROSS-ARM WITH 2 X 4½" MACHINE BOLTS.
GROUND WIRE COVER.
(USE TWO ARM CONSTRUCTION FOR 4 OR 6 WIRE SECONDARY)
TWO TRANSFORMERS MAY BE USED AS SHOWN FOR BANK CAPACITY OF 10-KW. OR LESS. FOR CAPACITIES ABOVE 10-KW. SEE PAGE C0602-2
Electric Standards
Southern California Edison Company
2-2300 VOLT TRANSFORMERS ON 4000 VOLT CIRCUIT, POLE TOP HANGING.
STREET SIDE 4000 VOLT 3 PHASE 4 WIRE PRIMARY
115-230 VOLT 3 WIRE SECONDARY
GROUND WIRE
INSULATOR TYPE FUSE BLOCK SEE B0401
"L" ARM
GROUND WIRE ON WHITE INSUL.
2300 VOLT CAMBRIC INSUL. WIRE
BOLT TO CROSS ARM WITH 2½" MACH. BOLTS
HOUSE SERVICE
"K" ARM
LEAVE THIS POSITION VACANT
LEAVE THIS POSITION VACANT
GROUND WIRE COVER
FOR K.W. CAPACITIES OF A B
0.6 TO 5 2'-0" 2'-0"
7.5 TO 10 2'-8" 1'-6"
15 TO 20 3'-6" 1'-6"
25 TO 50 4'-5" 1'-6"
Electric Standards
Southern California Edison Company
1-2300 VOLT TRANSF ON 4000 VOLT CIRCUIT, POLE TOP HANGING
GROUND WIRE POSITION
LEAVE THESE POSITIONS VACANT FOR CLIMBING SPACE
PRIMARIES
SECONDARIES
STREET SIDE
4'-0"
BILL OF MATERIAL
ITEM NO. | NO. REQD | DESCRIPTION OF ITEM | ELECTRIC STANDARDS
1 | 1 | POLE | C0010
2 | 1 | CROSSARM "L" | B1702
3 | 1 | CROSSARM "K" SERVICE ARM | B1702
4 | 9 | PIN TYPE INSULATOR(6 PIN) | B0107 (OR B0108) ITEM A
5 | 1 | PIN TYPE INSULATOR(6 PIN) (WHITE PORCELAIN) | B0107 ITEM B
6 | 4 | CROSSARM BRACE, 52" | B1101 ITEM B
7 | | GROUND WIRE COVER | C0782
8 | 2 | ¾" X 14" CROSSARM BOLT WITH 2 SQUARE WASHERS | B1602 ITEM B-1
9 | 4 | ¾" X 4½" BRACE BOLT WITH ROUND WASHER | B1602 ITEM C-1
10 | | ¾" X 6½" SPLIT BOLT WITH 2 ROUND WASHERS | B1602 ITEM D
11 | | ½" X 4" HEEL LAG SCREW | B1602 ITEM F
12 | 1 | BRACKET (FOR STREET LIGHTING CIRCUIT) | B0803
NOTE: WITH 4 OR 6 WIRE SECONDARIES USE AN ADDITIONAL "L" CROSSARM
Electric Standards
Southern California Edison Company
4000 V. PRIMARY & SECONDARY SINGLE CROSSARM DISTRIBUTION POLE TOP CONSTRUCTION

Typical 4,000-volt construction as adopted by the Southern California Edison Company showing method of hanging transformers and single crossarm pole top construction.



Typical 4,000-volt construction of the Southern California Edison Company showing method of mounting and connecting transformers.

connected transformers to the neutral ground wire and ground it at each bank, others do not connect any star-connected banks to the neutral and do not ground the primary neutral wire except at the station.

The same class of insulators, dead-ends, transformer bushings and other line material is used on 4 kv. construction as is used on 2,300 volts except along the coast in the salt fog districts. The general practice is to use ordinary 2,300-volt plug cut-outs up to 25 amp. on 4-kv. lines for protecting transformers except along the coast where lines are exposed to salt fog. Here the cut-outs are mounted on special insulator supports to prevent leakage or special higher voltage cut-outs are used.

For capacities above 25 amp. and in the salt fog districts such cut-outs as Mathews H. Q. and Q. K. West. No. 323795, Line Material 6,600 volts, etc. are used. Fig. 1 illustrates method used by one company to insulate the 2,300 volt plug cut-out from the cross-arm in territory subject to salt fog conditions.

Some companies are using three-phase 4-kv. regulators and others use three single-phase regulators. It has not proved satisfactory to connect the neutral of star-delta banks to the neutral ground wire when single-phase regulators are used. Any current unbalance on one phase of the line causes one regulator to boost the voltage of that phase and this unbalances the voltage between phase-wires and the neutral ground wire and if the neutral of a star-delta bank is connected to the neutral ground wire, currents will flow in the secondary delta due to the action of the bank to hold the voltage to neutral equal on all phases. Some companies ground the neutral wire at the station only and others at all power banks and at intermediate points where lighting transformers only are connected to the line, as well as at the station.

The last three conditions are the debatable ones on the coast, connecting the neutral point of star-connected power banks to the overhead neutral ground wire or not; single-phase versus three-phase regulators, and grounding at the station only or, at a great many places along the line, as well as at the station.

On four-wire 4-kv. systems using three-phase regulators in which the neutral of star-connected banks and the common wire of open-delta banks has been connected to the overhead ground wire, single phase lighting has been taken from the transformers just as it would be on a standard 2,300-volt delta system with the lighting transformer of a size necessary to carry the lighting load plus its share of the power load. On systems in which no connection is made to the overhead neutral wire, open-delta banks cannot be used and if lighting is taken from three-star connected transformers the difference in capacity between the lighting transformers and the power transformers must be small as the primary current from the lighting transformer must flow through the primary of the two power transformers and if they are much smaller they may burn up.

The accompanying drawings illustrate typical 4,000-volt construction as adopted by the Southern California Edison Company, the primary and secondary circuits being placed on opposite ends of the same cross-arms.

Investigation of Demand Meter Troubles

By F. C. GILCREST*

As was to be expected, the members of this committee reported numerous and serious defects in practically all types of equipment. In nearly every case at least part of the instruments in service were purchased during initial developments. In some instances, owing to the inherent characteristics of the apparatus, the manufacturers now consider a few of the earlier types of indicating devices to be obsolete. Improvements incorporated in the latest product of the manufacturers have eliminated many of the most serious defects so that the application of this equipment may now be made with more satisfactory results than was formerly the case. In spite of the advance which has been made it is still well to remember that demand instruments have not attained to the accuracy or reliability that now obtains in watt-hour meters.

Standardization of Electrical Measuring Instruments

At the annual convention of the American Institute of Electrical Engineers in June, 1923, H. B. Brooks presented a paper on the above subject. Included as a part of this paper was a proposed "American Specifications for Electrical Measuring Instruments." The committee has examined these specifications and has made the following suggestions for changes or additions:

III—Fundamental Definitions.

"A multiplier is a particular type of series resistor." Insert after the word resistor, "or reactor." This insertion is considered necessary to take care of induction type instruments.

"The scale length" to be defined as an arc drawn through the middle of the scale divisions from zero to the end of the scale, instead of the arc described by the end of the pointer. In the latter case, a useless extension of the pointer would give the instrument a greater scale length.

*Meter Bureau: C. F. Gilcrest, chairman; T. E. Knackstedt, W. C. Wells, J. J. Skinner, A. J. Hall, W. G. Knight, D. D. Smalley, W. C. Smith, B. G. Hatch, O. A. Knopp, W. N. Lindblad, G. H. Searle, R. Crowell, W. R. Frampton, A. S. Price, H. R. Thomas, J. C. Albert, W. H. Talbott, T. P. Garrett, F. E. Dellinger, J. M. Morris, J. E. Bridges, G. A. Collins, Lou Johnston, L. A. Nott, J. G. Monahan, R. G. Jones, A. L. Duesbury, R. S. Daniels.

"(c) The voltage influence." The plus or minus 10 per cent change from rated voltage will, for instance in the case of a wattmeter, change the indication plus or minus 10 per cent. It is therefore suggested that a reservation be made as— "assuming the numerical value of the quantity measured remains constant." In the case of a wattmeter the wattage should remain constant.

"(e) The power factor influence." A reservation is suggested to prevent overloading the current coil. If a test is made at full scale the current would double. By determining the error at half-scale deflection, this would be avoided.

V—Requirements.

"Dielectric strength tests." This clause seems to exclude ammeters calibrated with a high voltage current transformer. A thousand volt test would not be high enough to take care of such instruments. It was already specified that "an instrument is defined as a measuring device which may consist of an indicator together with an instrument transformer."

The committee also gave consideration to a suitable definition for the rating of instrument transformers. A very satisfactory method would be to base the volt-ampere capacity on a definite percentage change in ratio and phase angle for a certain definite change in secondary burden. In this connection it was the unanimous opinion that it would be very desirable to have available a current transformer designed for a secondary burden of two or three volt-amperes whose ratio error would not exceed + or — .5 per cent and the phase angle not to exceed 10 min. between 10 per cent and 100 per cent of the normal primary current.

Kva. Metering

It is the function of the Meter Committee to consider this subject only as it relates to instruments designed for the above purpose and their maintenance. There are several instruments available for measuring kva. and kva.-hr. Their descriptions have already appeared in committee reports. In addition to the quantities just mentioned some of these meters also record the kilowatt demand and the kilowatt-hours.

Up to the present time we believe there are no installations in this state where meters are being used to record kilovolt-ampere hours directly. If the rate making authorities decide in favor of a more general application of this type of schedule it will be possible to secure the instruments for this purpose but it is well to bear in mind that the equipment is not of established reliability which is obtained from standard watt-hour meters and will therefore require much closer supervision.

Theft of Current

It is considered inadvisable to discuss the details of this subject for general publication. It is sufficient to state that the manufacturers are cooperating with the utilities to provide installations which will be reasonably secure from unlawful tampering. By introducing slight changes in the meter construction and also by combining the meter with iron clad service switches the possibility of interference is decidedly reduced. As far as it is possible to secure information we believe that the theft of current is not as prevalent in this section as it is in some other parts of the country.

New Developments in Meter Accessories

For some phases of meter testing work it is required to accurately measure time intervals. One of the members, O. A. Knopp, has devised a pendulum and relay combination for performing this function which operates very satisfactorily. It was reported that the Westinghouse Electric & Manufacturing Company has designed an attachment to be applied to RA demand meters whereby any number of these instruments may be operated in synchronism. The arrangement is such that one clock operates all of the tripping mechanisms. This device requires a pair of connecting wires between all the instruments.

The committee investigated a new type of potential switch, involving a mercury contact, for use with rotating standards. While this scheme possesses some very desirable features it has not as yet proved altogether satisfactory.

Power Measurements on Circuits with Paralleled Current Transformer Secondaries

The committee investigated the accuracy of this method when three circuits were involved. The registration of a totalizing meter was compared with the sum of three individual meters supplied by separate current transformers. Variations of both current and power factor were produced and under all conditions the results were very satisfactory. The maximum error determined was approximately 1 per cent.

Outdoor Metering Equipment

An analysis of the comparative costs of indoor and outdoor types of instrument transformers shows that while the indoor type is the cheapest it may become the more expensive to use if a housing structure has to be built to protect it from the weather. Combination metering units in which both current and potential elements are all contained in one tank cost approximately 75 per cent higher than separate units of the outdoor type when considering the same manufacturer's product. This difference is somewhat overcome by the greater installation cost for the individual units. As between different manufacturers' products there is a wide disparity in prices. In this territory the individual outdoor units have proved the most popular as they have been used in the great majority of cases.

Standard Testing Facilities

The committee finds that some of the members have adopted very satisfactory arrangements for testing consumers' meters of large capacity. The report includes description of two and three wire d.c. installations as well as single and polyphase a.c. installations.

Transformer Cooling

By E. R. STAUFFACHER*

THE subject of cooling of transformers is one which is of considerable interest to the central stations on the Pacific Coast at this time. The comparatively high temperature and the scarcity of a large supply of fresh water, such as lakes or rivers, in the inland valleys has necessitated that special means be devised to successfully cool station transformers. The subject is so important that it was decided to devote a good part of the time of the Apparatus Bureau to this subject.

In general, due to the lack of a large supply of fresh water at the substations it is necessary to adopt means of cooling and re-circulating the water used for transformer cooling. A spray pond or cooling tower is used for cooling the water and the results are satisfactory from this standpoint. However with the gradual evaporation and the addition of only make-up water to replace that lost by leaks and evaporation the mineral content of the cooling water gradually increases. This accelerates the formation of scale in the water coils in the transformer with the resulting loss in efficiency of heat transfer. To overcome this tendency to excessive scale formation various systems of water softening have been installed and are giving satisfactory service but in the larger sub-stations the maintenance of these systems becomes rather burdensome.

Systems of oil circulation in place of water circulation through the coils as well as systems which circulate the insulating oil directly without the use of coils in the transformer are used with success. The warm oil is cooled by circulation in coils or radiators which are located exterior to the transformer and which are immersed in water or upon which water is sprayed.

The Pacific Gas and Electric Company reports that

*Apparatus Bureau: E. R. Stauffacher, chairman; Roy Martindale, H. H. Cox, C. P. Garman, J. C. Albert, O. W. Wingard, O. G. Steele, Paul Ost, James F. Pollard, T. W. Snell, E. K. Gynn, H. M. Buck, G. E. Armstrong, J. H. Cunningham, Allen Jones, J. A. Koontz, C. F. Benham, G. A. Edley, F. R. Knight, A. J. Hall, E. A. Crellin, B. D. Dexter, H. T. Sutcliffe, S. J. Lisberger, W. H. Talbott, K. P. Ayers, Emery Sherwin, C. E. Schnell, R. C. Denny, H. S. Miner, M. L. Crum, J. L. Thompson, L. J. Moore, W. R. Battey, R. M. Peabody, F. H. Mayer, J. C. Gaylord, L. L. Dyer, R. H. Halpenny, M. L. Baden, Paul H. Yelton, F. V. Wright, W. P. L'Hommedieu, R. A. Hopkins, W. A. Copley, J. E. Bridges.

at a sub-station where the cooling water contained a large percentage of chemicals that had a tendency to form scale, a cooling system using distilled water was installed and is working satisfactorily. The distilled water is circulated and is cooled by means of the natural scale-forming water flowing over external radiators. Self-cooled transformers are used to a large extent on the Pacific Coast but the difficulty of moving larger capacity transformers equipped with large radiators offers quite a problem.

A number of reports are submitted covering various phases of the problem of cooling transformers. This subject is one which should be given most thorough study by the manufacturers of transformers for it is felt by the operating companies that better means could be devised to solve this problem.

A New Development of the A.B.O. Type Transformer

The letters "A.B.O." have been designated as the type designation for an oil-insulated transformer cooled by air blast. Heretofore developments on the A.B.O. type have been confined to the application of a comparatively large blower equipment forcing a large volume of air at low pressure along the cooling surfaces by means of shields or deflectors. A reduction of about 50 per cent in the oil rise was obtained by this method of cooling, but the saving in cost as compared with a straight self-cooled unit was small due to the large capacity blower and motor and quite expensive casing required. This small saving in cost precluded the general use of this type of transformer, though a few units were built.

Recently further experiments have been made to determine the minimum amount of air required to obtain the same result—i.e., a 50 per cent reduction in oil rise. Tests show conclusively that it is necessary to apply only a small volume of air in the form of small jets to the radiating surface and at moderate pressure. Only enough air is required to break up the air film on the radiating surface and set this air in circulation. By this new method the same reduction in oil rise is obtained at much lower cost due to the small blower and motor required combined with a simple design of air deflector.

The air piping is so arranged as to direct small jets of air on the radiators at advantageous positions, to increase the cooling efficiency.

Estimates indicate that the A.B.O. type transformer price will be approximately half-way between the standard water-cooled and the standard self-cooled types as shown in the following tabulation:

Kva.	W.C.	A.B.O.	H.
2,500 to 10,000	100 per cent	125 to 130 per cent	150 to 160 per cent

These percentages include the cost of the blower equipment, and are for either indoor or outdoor service. The saving for this type increases with the increase in capacity. Efficiencies will be approximately the same as water-cooled efficiencies. Another important feature of the development is that the radiators may be detached from the transformer tank and all placed in a nest by themselves. The radiators for two or three banks of transformers may thus be installed in a single unit so that the oil circulation may be maintained in all the transformers continuously.

Application and Advantages

1—The A.B.O. type will be applicable for installations where water is not available, not suitable or expensive.

2—This type may also be used instead of a straight self-cooled transformer where the ambient temperature may be above 40 deg. C.

3—It is applicable to locations where there is a great variation in load. Since the tank is provided with a large radiating surface, there always will be a self-cooled rating of 40 to 50 per cent of normal kva., with the blower shut off.

4—Another important feature is that a spare transformer or a spare bank of transformers may be connected into the cooling system so as to be available for instant service.

5—Repairs can be made readily.

6—Cooling system may be independent of the transformer tank. This may be important where floor space is limited. If desired the transformer may be located indoors and the cooling system outdoors.

7—The tank may be designated to fit the core and coils and may be made much shorter than would be used normally.

Although no transformers of this new type have been placed in service, the manufacturers are satisfied with the tests made and will soon be in a position to place them on the market.

Description of Natural Cooled, Oil-Circulated Transformer Cooling System Located in Long Beach, Calif., and Designated as Pine Avenue Sub-Station, Southern California Edison Company

This installation of transformers, is of the outdoor natural cooled type, being 3 units of 2,000 kva. each. The installation of the second bank having a similar capacity is now in progress.

The substation site was approximately 25 ft. x 52 ft. and in order to accommodate the present and future needs, a three-story and basement concrete building was erected. The transformers are located in the basement and in order to have better air circulation and consume less floor space, the radiators were removed from the transformers and placed in a structural steel rack located on the roof. The present and future racks were designed for 2 banks of 18 radiators each, located in a suitable position to utilize the sea breezes for cooling.

The following is a description of the various units and system employed to circulate the oil from the transformers to the radiators.

The oil is taken from a point located on the upper part of the transformer shell (thereby getting the hottest oil in the case) through a common 2½ in. suction line to a vertical Byron Jackson 2 in. x 11 in. centrifugal 60-gal. per. min. pump direct connected to a 5-hp. induction motor and delivered against a head of 74 ft. through a 2½ in. pipe to a common header connected to the bottom of the radiators. The oil then circulates through the radiators and through a top header passing into a storage tank located on the roof. This tank has gauge glasses, 2½ in. overflow and breather connections. Note that there is only one breather connection for the whole system. The oil then passes from the roof tank through a 2½ in. pipe line and a system of float valves to a 2-compartment equalizing tank in the basement whereby the oil in the upper compartment is automatically maintained at a constant level. This arrangement is used to reduce the pressure on the line from the roof to the equalizing tank so there will be no pressure on this tank. The 5-in. equalizing line is connected from the equalizing tank to the transformers and is designed to replace the oil as fast as it is withdrawn by the pump. The oil level in the transformer conservator tank drops 5 in. when the pump is in operation. This 5-in. drop is required to get the gravity flow from the equalizing tank to the transformers. The lower compartment is used as an overflow tank and only a few inches rise in the equalizer tank will ring a bell and overflow into the lower compartment where it can be picked up and recirculated in the system.

The outstanding feature of this pipe hookup is, there is no pressure on the transformers more than the normal filling. This system has been in operation for the last six months and to date has been very successful.

Transformer Cooling—Bureau of Power and Light, City of Los Angeles

The Bureau recently installed a Braun cooling tower at its substation No. 1, in connection with an enlargement of the station. This tower at the present time is considerably underloaded. It is evaporating about 0.8 per cent and the Bureau is highly pleased with its operation. This station formerly used untreated city water, and considerable trouble was had with scale. A water softener was later installed, claims being made that the softened water would gradually dissolve the scale in the pipes. (Coils had been cleaned with acid.) These claims were disproved when some of the old piping was torn down, as it was found very badly encrusted with scale.

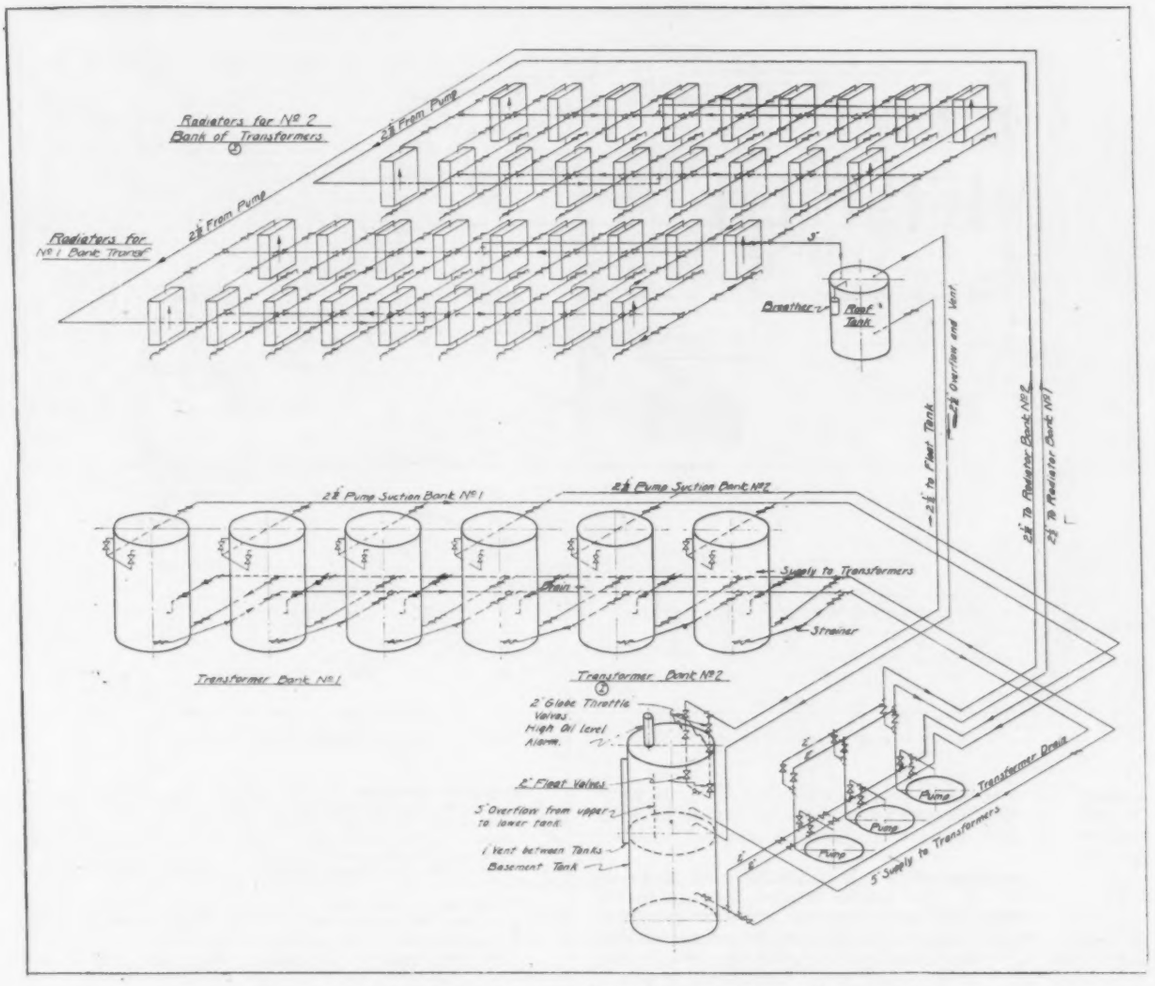
In the design of the piping and pumping layout for the above-mentioned enlargement, particular attention was paid to having piping large enough to allow for the scaling up and rusting up of the piping in service. Allowance of from 50 per cent to 80 per cent in excess of the theoretical, carrying capacity of piping, was made to cover this point.

Tests made on a number of representative transformers gave the following results:

Velocity of flow through cooling coils
New transformers, 275 ft. per min.
Old transformers, 200 ft. per min.

The old transformers tested were some in which the coils had been recently cleaned with acid. The conclusion drawn from the above, therefore, is that much of the difference in velocity is due to increased friction caused by roughening of the coil surface by corrosion.

The installation of standard water meters on some transformer cooling coils as flow indicators is being considered—using them, possibly, as both indicating and integrating meters. The test dial on standard meters of smaller sizes is one cubic foot per revolution, which, even on small cooling coils, would run at a fair speed for indicating purposes. The use of the integrating



Transformer oil piping at Pine Ave. Substation, Southern California Edison Company.

feature above suggested, would be for the purpose of making studies over a period of time to determine the amount of decrease in flow due to scaling or rusting. If desired, the register train could be removed and a large hand attached directly to the meter shaft thus giving a higher speed to the indicating pointer.

This Bureau has been using standard water meters for several years as flow indicators in the oil and water lines to vertical generator thrust bearings, with excellent results. No trouble is anticipated in using them on transformers, provided the cooling tower is kept free from moss.

The cost of the meters is, approximately, as follows:

¾ in.	$13.00
1 in.	19.00
1½ in.	36.00

Experiments on Cooling Transformer Oil in Automobile Type Radiators

During July and August, 1923, the engineering department of the Southern California Edison Company conducted some tests on a small scale to determine the efficiency of an automobile type radiator in cooling transformer oil. The reason for undertaking these tests was to find a means of cooling transformers which would be low in first cost, economical in operation and would do away with the trouble frequently encountered in water-cooled installations. Except at the hydraulic plants, there is rarely a supply of water sufficient to use without re-circulating through a cooling tower, and the water is frequently of such hardness that it is necessary to install water softening apparatus to prevent scale deposits in the transformer cooling coils. For transformer installations of 12,000 kva. and upward, the water softening apparatus is quite expensive and requires considerable attention to operate properly. Other difficulties with water-cooled systems are the necessity for frequently renewing the water in the cooling system due to the concentration caused by continual evaporation, and also frequent cleaning of the cooling tower. The self-cooled transformers in the larger sizes (3,000 kva. and up) are quite expensive in first cost.

The general layout of the apparatus used in the tests is shown in Fig. 1. The oil was heated by passing it through two 5,000 watt Everhot heaters. The temperatures were measured by calibrated thermometers in thermometer wells at the inlets and outlets of the radiators. The oil was circulated by a centrifugal pump and the flow measured volumetrically in a tank. Air was blown through the radiators by a Buffalo Forge Company blower and the air velocity measured by a pitot tube connected to an Ellison draft gauge. The temperature of the air entering and leaving the radiators was recorded. The heat balance between the oil and the air was calculated for each test and if the balance was not reasonably close the test was re-run.

The radiators were arranged in a battery of five and the connection so valved that oil could be run through one or more radiators in parallel or in series at various velocities. By varying the speed of the blower, tests were made at several different air velocities.

The radiators used were made by the Bowerbank Radiator Company of Los Angeles, shown in Fig. 1. These radiators offer a direct passage for the oil and air and present a large cooling surface. Each radiator was nine inches square and four inches deep in the direction of the air flow. The cooling surface in each radiator, counting the area of metal in contact with the oil, is 12½ sq. ft. Tests were made with oil velocities in the radiators varying from 0.05 ft. to 1.00 ft. per

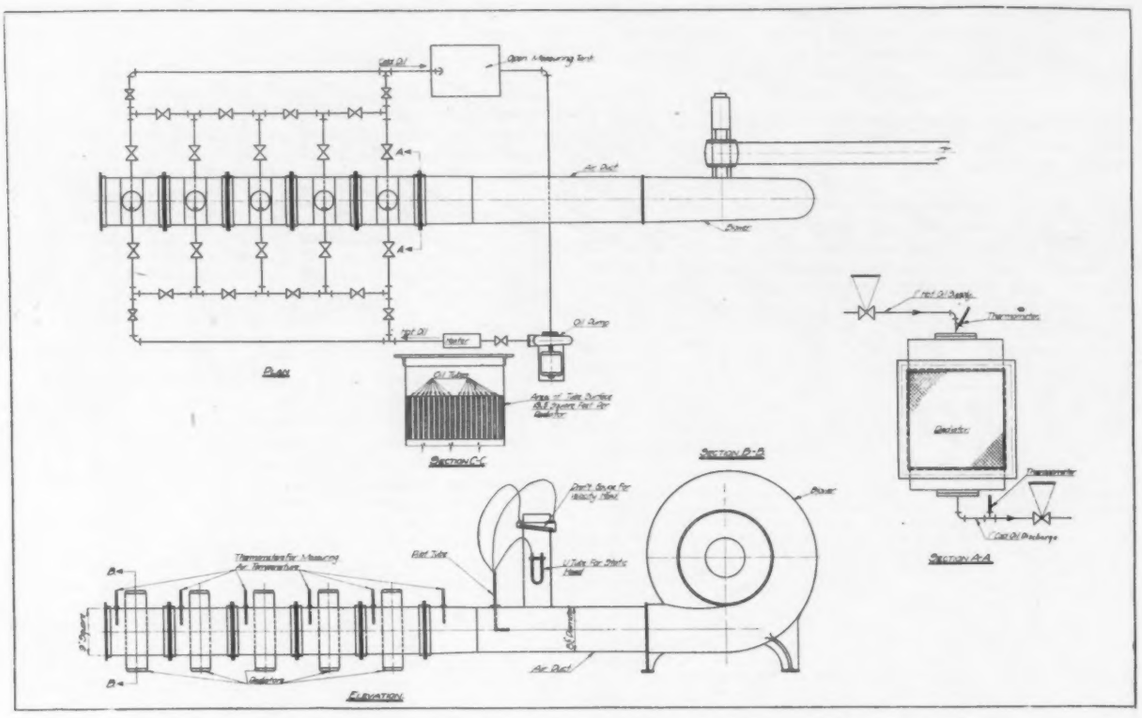


Fig. 1.—Layout of testing apparatus for cooling transformer oil using automobile type radiators.

second, and with air velocities from 1,170 ft. to 2,920 ft. per minute. Figs. 2 to 9 show the rates of heat transfer obtained for the range of oil and air velocities tested.

The tests showed that a heat transfer of 20 to 25 B.t.u. per sq. ft. per degree temperature difference was easily obtainable and estimates based on this rate of heat transfer indicated that a radiator installation for a bank of three 5,000 kva. transformers would cost somewhat less than a cooling tower installation where a water softener was necessary in addition.

An installation on the above lines is now being made to cool the oil in a bank of three 5,000 kva. transformers. If this proves successful, further tests will be made to determine the best type of radiator to use and the most efficient arrangement of radiators.

In this installation the radiators are placed inside a stack about thirty feet high, so that natural draft may be used during cool weather and at times of low load, and it is believed that the blower will be necessary only in hot weather and over peak loads.

Some of the large manufacturing companies have conducted several investigations on the effect of different colors of paint on cooling of tanks and have found that corrugated, tubular and radiator types of tanks are not affected by the ordinary colors used on transformers, such as black and light gray. In fact it would not be expected that the heat dissipated would be appreciably affected since most of the loss is carried away by convection currents upon which color has no effect. The situation is slightly different where there is a plain tank in which case a little more than one-half of the loss is dissipated by radiation which is affected by color.

"So far as absorption of heat by the sun's rays is concerned, it may possibly be a little better to have the tank painted a light color although it is felt that it will not make very much difference one way or the other, when the tanks are not plain.

"For plain tanks it would be expected that the advantage of the light color is a little more than for a corrugated, tubular or radiated surface.

"It appears, therefore, that the choice of color resolves itself more into a matter of appearance and durability rather than of any effect that it has on heating."

"* * * it is known that so far as tanks with irregular surfaces are concerned an aluminum bronze paint is practically as good as a black paint. For a plain surface, investigation shows that an aluminum paint will give about 20 per cent higher temperature rise in the shade than a black paint. But if the plain area is in the sunshine there is not very much difference in the temperature rise of the different colored tanks, because the decreased radiation due to the lighter color is offset by the decreased absorption.

"At present there are very few accurate data on the absorption of heat by tanks having irregular surfaces, painted with aluminum bronze. However it is not logical to expect that if, under any set of conditions, the temperature is not increased due to decreased radiation that it would be increased due to increased absorption. In other words, the two effects should be approximately equal and opposite.

"The above, however, does not mean that a tank will not run slightly warmer in the sun than in the shade whatever the color.

"The conclusions on this subject are as follows:

1. For plain tanks in the shade a black color gives a lower temperature rise than light colors, the percentage being approximately as follows:

Black	100 per cent
Dark Green	101 per cent
Dull Red	104 per cent
Dull Gray	110 per cent
Dull White	117 per cent
Aluminum	120 per cent

2. For plain tanks in the sunshine there is very little difference (not over 2 or 3 deg. C.) between the relative heating, although of course, all of them will naturally give somewhat higher rises in the sunshine than in the shade.

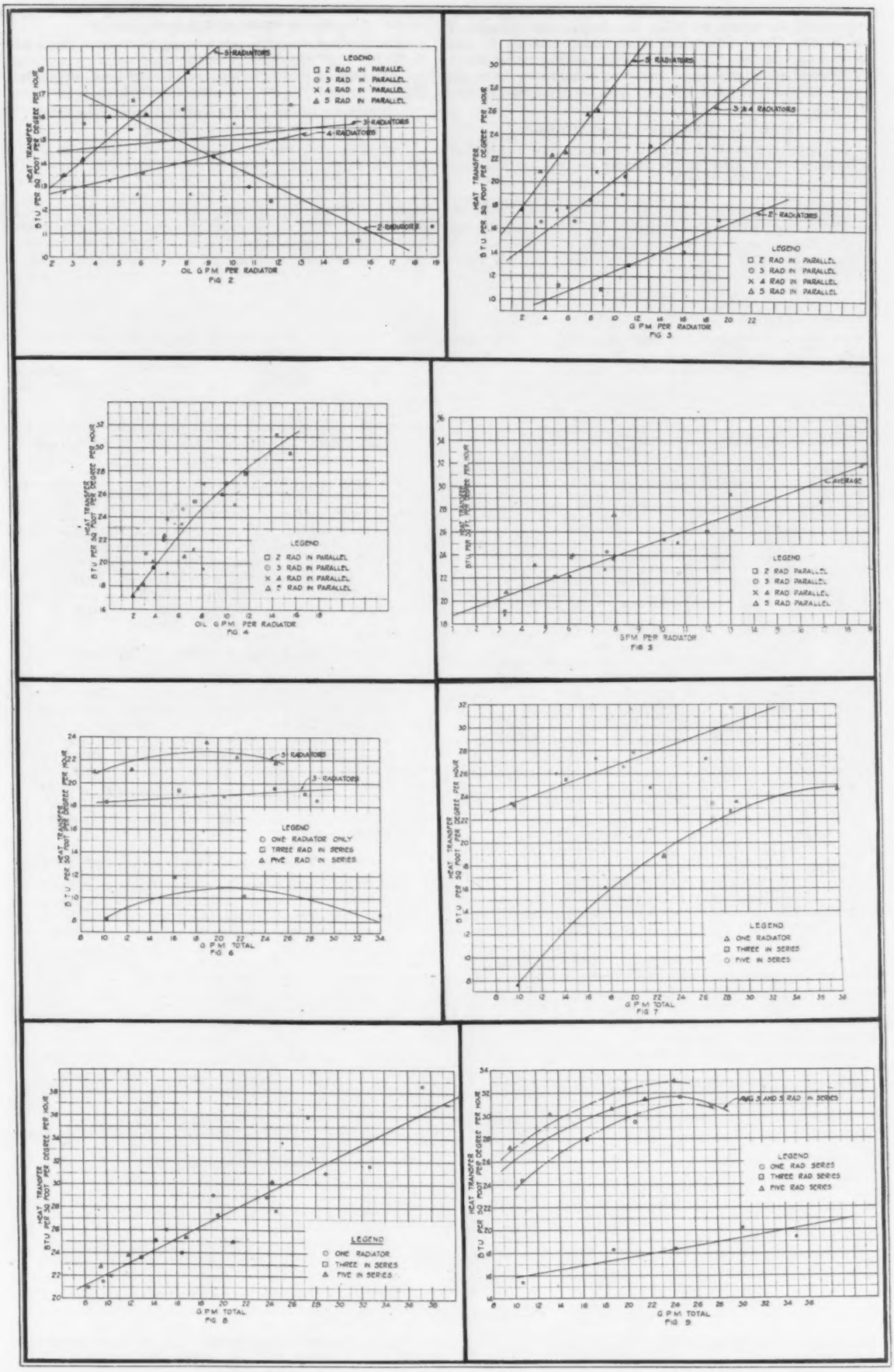
3. For tanks with irregular surfaces (where most of the heat is dissipated by air convection currents) color has very little effect on the heating in either the shade or sunshine."

The Bureau of Power and Light of the City of Los Angeles has planned to use an air jet system for the cooling of the feeder regulators in the new 30,000 kva. Hollywood Substation. Round hollow tile will conduct the air furnished by a blower to a series of floor ventilator caps located between groups of single phase feeder regulators. It is planned to use from 250 to 300 cu. ft. of air per min. per group of two 4,800/2,400-volt-150/300-amp. single-phase regulators. The air pressure will probably be 4 oz. of water.

This appears to be an economical way in which to accelerate the cooling of oil insulated self-cooled equipment and it is hoped that a more complete report can be furnished next year.

Directed Ventilation of Rotating Machines

At the beginning of the year it was thought that the subject of directed ventilation of rotating machines was one on which there was very little information available and consequently would justify a detailed study and discussion. In October 1923, however, the excellent report of the Sub-Committee on Ventilation by the Electrical Apparatus Committee, Technical National Section, was published. This report entitled, "Ventilation of Central Station Buildings and Equipment"



Figs. 2-9.—Showing rate of heat transfer in tests of automobile type radiators for cooling transformer oil.

covered the subject so thoroughly that it was felt that little could be added to it by the Apparatus Bureau of the Pacific Coast Electrical Association and so it was decided to augment this report with photographs showing typical installations of rotating machinery with directed ventilation as developed and used on the Pacific Coast.

Automatic Reclosing Circuit Breaker

Automatic reclosing circuit breakers are beginning to be applied on some of the larger central station systems on the Pacific Coast. One of the companies reports the successful use of this equipment on a number of its more important substations. The automatic reclosing circuit breaker mechanism was furnished by one of the larger manufacturing companies. Another operating company reports placing an order for approximately thirty sets of this equipment and expects to install it within the next six months. Another Pacific Coast company reports the use of re-closing circuit breaker mechanism with the necessary relays, all of which were developed by the engineers of that company. This last mentioned company, the San Joaquin Light & Power Corporation, states thus:

"This mechanism is applicable to any type of switch or oil circuit breaker which trips out from overload, reverse power, or other reason and which it is desired to re-close in a definite time and for a definite number of tryouts if trouble still persists and then lock out the control mechanism of that particular switch, should the trouble not be removed.

"The re-closing mechanism with its interval and limit switches is the same regardless of the number of switches to be re-closed, each switch having its own pin engaging solenoid, slide-rod, pallet switch and control relay. The scheme can be applied to one or any number of switches, and all will close, one at a time only, and in their proper sequence, and only the switch which has kicked out will be re-closed.

"Power for operation of the automatic re-closing mechanism is obtained from a transformer at 110 volts and so located as to be not interrupted when any of the switches to be re-closed kick out. All relays and the single phase motor for the re-closing mechanism operate on 110-volt, 60-cycle current."

The relay which is used is manufactured by the Western Electro-Mechanical Company of Oakland, California. One of the manufacturer's representatives in the Apparatus Bureau has submitted a report covering in general the status of automatic a.c. substations throughout the country. This field is so closely allied to automatic re-closing circuit breakers that it was thought that it would be advisable to incorporate it in this report.

The study of automatic re-closing circuit breakers should be continued and it is suggested that a committee keep on with this work next year. Particular reference should be given to reports on operating troubles so the manufacturers may have as much detailed information as possible by which to correct any defects in design.

Automatic A.C. Substations

One of the manufacturers' representatives of the committee has submitted the following covering in general the status of automatic a.c. substations throughout the country.

Automatic switching has been successfully applied to the operation of incoming lines, transformer stations, and outgoing feeders. In this application the major function is the operation of a particular circuit breaker, or group of circuit breakers, in response to either overload, underload, undervoltage, reverse current or unbalanced power. In other words the automatic switching equipment performs the same operation as would be performed in the case of manual control, only with a more positive and direct action.

Equipment for a.c. substations may be conveniently grouped as follows:

1—Incoming Lines.

(a) Preferential-emergency incoming lines from a common source.

(b) Preferential-emergency incoming lines from two independent and presumably non-synchronized sources.

(c) Parallel or tie lines.

2—Transformer Stations.

(a) One transformer bank.

(b) Two transformer banks with "leading" and "trailing" banks.

(c) Two or more transformer banks with "leading" and "trailing" banks, plus an emergency line.

3—Outgoing Distribution Feeders.

(a) Equal time intervals between re-closures, any number of breakers re-closing simultaneously.

(b) Equal time intervals between re-closures with a limited number of breakers re-closing simultaneously.

(c) Unequal time intervals between re-closures, any number of breakers re-closing simultaneously.

(d) Unequal time intervals between re-closures, with a limited number of breakers re-closing simultaneously.

Incoming Lines. Preferential-Emergency from a Common Source

At times a.c. substation busses are fed from a generating source by means of two incoming lines. The high tension voltage at the substation is stepped down, as the case may be, to a bus to which the outgoing leaders are connected. One type of a pair of incoming lines is known as "preferential-emergency incoming lines from a common source." Either line may be made the preferential. Voltage failure for a definite time on any phase of the preferential line opens the breaker of this line, and then, if voltage conditions are correct, the emergency line is connected on. Voltage for tripping the preferential line is obtained from the emergency line. The re-establishing of proper voltage conditions on all phases of the preferential line, for a definite period of time, re-connects this line, after which the emergency line breaker is tripped. This permits a transfer without dropping the load.

Incoming Lines. Preferential-Emergency from Two Independent and Presumably Non-Synchronized Sources.

Where the preferential and emergency incoming lines are connected to two independent sources which are not necessarily in synchronism, the operation differs slightly from that mentioned above. The same indications are used for tripping, connecting and reconnecting, the principal difference in operation being that the line breakers are tripped so that the two lines are not connected to the station bus at the same time. Therefore, in switching from one line to the other, the load is momentarily dropped.

Incoming Lines. Parallel or Tie Lines

Parallel or tie lines are provided with the customary balanced power protection. The outgoing feeders are of the radial type. Re-closing is obtained after proper voltage conditions have been re-established for a definite time on all phases of the line which was disconnected. Equipments of the types mentioned above permit an automatic a.c. substation to obtain its supply over two independent lines with the inherent advantages of continuity of service and sectionalizing of the faulty line. Supervisory control and indication may be readily adapted to the above.

Transformer Stations. One Transformer Bank

Transformer stations containing only one transformer bank and a number of outgoing feeders, serve as an excellent example of supplying power to load centers of an economical size in the vicinity of a high tension transmission system. The load is usually mixed industrial and lighting. The transformer in such a case is usually protected by differential and thermal relays.

The automatic operation of such a station is entirely that of the outgoing feeders. The transformer bank is switched on manually and left in this manner until either tripped off manually or by the action of the transformer protective relays. The operation of the outgoing feeders is described in a following section.

An automatic transformer station of this type will provide the following:

(a) Permit the development of new load centers for serving small communities.

(b) Convert attendance charges into profit.

(c) Re-establish service in a positive manner and in a minimum time.

(d) Feeder copper may be decreased by the proper location of a number of such stations.

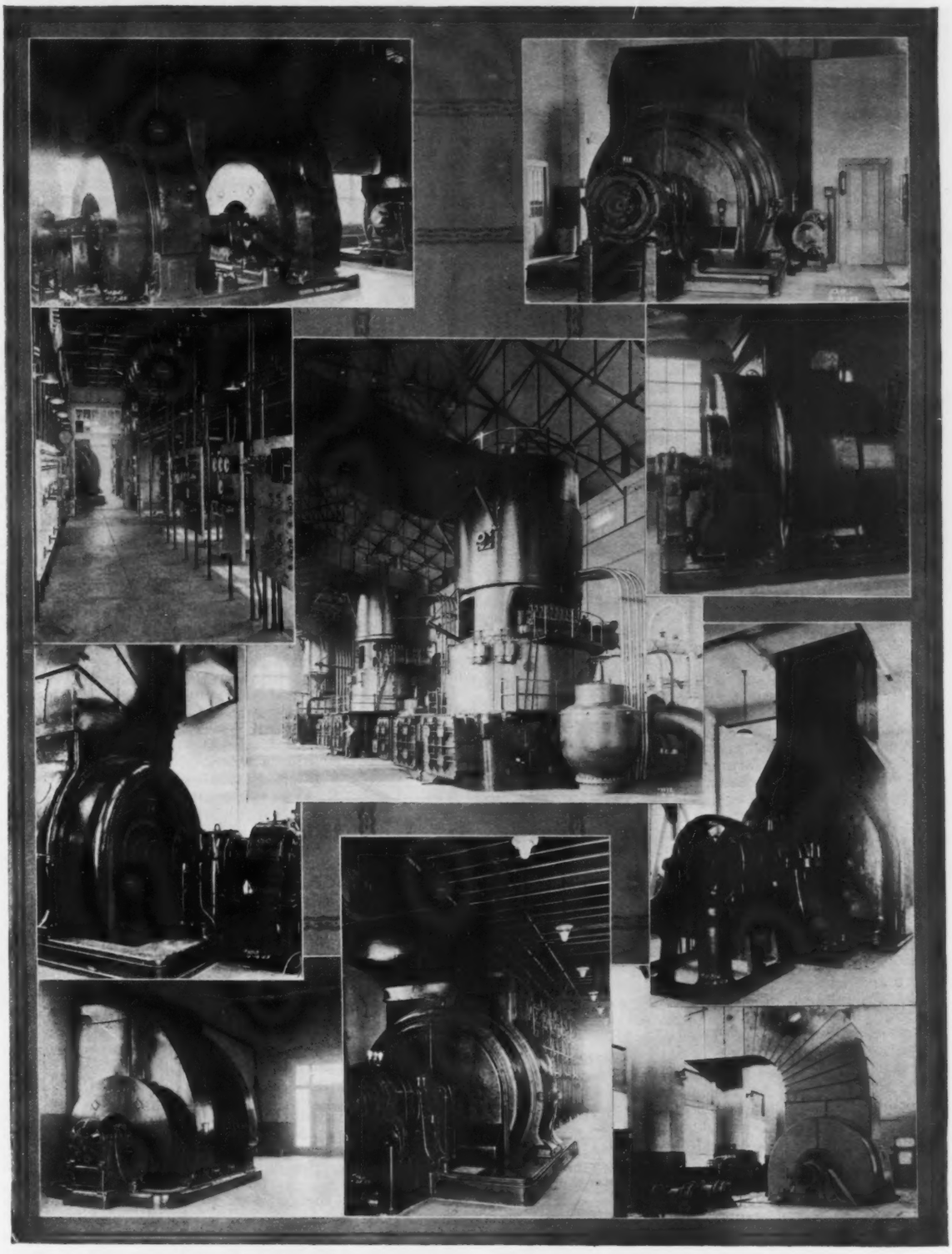
(e) Sectionalizing of the load may be obtained so that serious troubles may be isolated thereby affecting a minimum portion of the distribution system.

Supervisory control and indication may be readily added to such stations so as to allow the control to be centralized at one point, as for example, the load dispatcher's office. Any oil circuit-breaker may be operated in this manner and an indication obtained of its operation at the remote point.

Transformer Stations. Two Transformer Banks with "Leading" and "Trailing" Banks

Transformer stations are sometimes used where one transformer bank has sufficient capacity to take care of the light load in between peak periods with a second transformer added in response to load demand during the latter periods. Such stations are used where the saving obtained justifies the addition of a second bank with its control. The operation of such a station consists in switching on or off of the transformers, in response to load demand, and in the operation of the feeders. Inasmuch as the feeders are described later only the operations appertaining to the transformers proper will be discussed here.

Differential and thermal protection is provided as previously mentioned. It is possible to make either transformer "leading." The selection is usually made by throwing a double throw switch to the proper position. A totalizing contact making ammeter in each phase measures the total current supplied the low tension bus. At times this current is measured on the high tension side, but due to the saving effected by the use



Typical installations of rotating machinery with directed ventilation as developed and used on the Pacific Coast.

of lower voltage current transformers, it has been found advisable to place these transformers on the low tension side. A different set of transformers must be provided for totalizing, than that which is used for differential and thermal protection.

Continued overload for a definite time in any one phase of the "leading" transformer bank will bring on the second or "trailing" transformer bank. Continued underload, for a definite time, in all phases will drop off the second or "trailing" transformer bank. In case of loss of voltage on the incoming line supplying the "leading" bank, the high and low tension breakers trip before the second bank is brought on. The re-establishing of proper voltage on the "leading" bank will re-connect the latter on again, after which the "trailing" bank will be dropped off or remain on as determined by load conditions.

The operation of the thermal device on either transformer bank will drop that particular bank out of service and hold it there until opportunity is afforded for it to cool as determined by the length of time required for the thermal relay to reset. Operation of any differential relay trips out both the high and low tension breakers of the respective bank. These relays are hand reset, which necessitates inspection and location of trouble before the bank is replaced into service.

Besides having the advantages set forth in the preceding type of substation, this type of substation provides:

(a) Minimized losses during light load periods.

(b) Flexibility of operation, with a greater dependability of power in case of line or apparatus failure.

Supervisory control and indication may be readily adapted to this type of substation. Time switches may be provided in place of the contact making ammeters and also for operating lighting feeders.

Transformer Stations. Two or More Transformer Banks with "Leading" and "Trailing" Banks Plus an Emergency Line

A more advanced form of automatic substation is obtained when two or more transformer banks are used together with an emergency line and its transformer bank. The latter may replace any or all transformer banks, in the case of failure of the other lines or of a failure or overheating of any transformer bank. Such substations are usually located in large cities where an opportunity is provided, due to the widely changing load, to use a number of transformer banks, and where, due to the dependability of power required, an emergency line must be provided.

In such a substation, differential and thermal protection is provided for the transformers. The operation of the outgoing or distribution feeders is described in a following section.

Assume that there are three incoming lines with their respective transformer banks and an emergency line with its respective bank. During light load periods one bank can carry the entire load. Each bank has its own supply line direct from the generating source. Bank No. 1 carries the load during light load periods. Due to increased load as shown by increased current in any phase for a definite time, indicated by totalizing ammeters, Bank No. 2 is connected on, and the substation bus is "cut" so that Bank No. 1 feeds its share of the load direct, while Bank No. 2 carries the remaining outgoing feeders. A further increase in load demand, brings on Bank No. 3 and the substation bus is further "cut" so that each bank feeds its own share of the load direct and without any interconnection with the other lines. Radial feed, direct from the generating source, simplifies the control and eliminates complicated protective circuits that would otherwise arise.

If, while Banks No. 2 and No. 3 are connected on, and the load decreases in all phases, for a definite time, the station bus will be re-connected so as to transfer the load to either Banks No. 2 and No. 1, or No. 1 alone (as the case may be) without dropping the load.

Voltage failure or overheating will drop off any bank which in turn will be replaced by the emergency bank. Re-establishing of proper voltage conditions or cooling will re-connect the particular bank after which the emergency bank will be disconnected. This type of station has a greater degree of flexibility and provides for a greater continuity of service than those previously described.

Outgoing Distribution Feeders

Practically all outgoing feeders are of the radial type. In general the operation between various types of control differs but slightly. After the breaker has opened on overload it remains open for a time interval (which may be equal or vary) and is then re-closed regardless of external circuit conditions. In this way the operation duplicates that usually obtained manually. This operation is repeated a number of times at suitable time intervals, and if the circuit conditions are such as to cause further tripping the breaker is locked out by a hand reset relay. The disappearance of overload conditions before a fixed time has expired allows the control equipment to reset and thus have available a fresh sequence of operations.

The operation of these equipments is identical whether used in manually or automatically operated substations. They have proved especially applicable to large manually operated substations with a large number of outgoing feeders.

These equipments are in general a grouping of standard devices acting as a unit. The main circuit interrupting device is the same as used in manual operation with a possible addition of a suitable mechanism. The assembly of the devices on a structural steel framework for voltages up to and including 6,600 gives sufficient compactness and rigidity so that the equipment may be treated as a unit in its course of manufacture, shipment, installation and operation. For voltages over 6,600 it has been found desirable to locate the breaker, mechanism, etc. remote from the switchboard panel.

One type of outdoor equipment has been designed in which a standard indoor breaker, with mechanism and relays are placed in a suitable steel housing. A second type of outdoor equipment is designed so as to least alter the general construction of the circuit breaker supporting framework. In other words, the enclosing case for the relays, panel and mechanism is adapted to the breaker.

Outgoing Distribution Feeders. Equal Time Intervals. Any Number of Breakers Re-Closing Simultaneously

Equal time intervals between re-closures are provided by the use of a definite time-delay relay which resets after each closing operation of the circuit breaker. The tripping of the breaker also actuates a notching relay which, in a way, counts the number of operations. If a breaker trips a sufficient number of times, within a fixed time interval, the contacts of the notching relay open and prevent further automatic operation. The notching relay must then be reset by hand. In one form of this control no provision is made against overloading the control source due to the closing a number of breakers simultaneously.

Outgoing Distribution Feeders. Equal Time Intervals, with a Limited Number of Breakers Re-Closing Simultaneously

The operation here is the same as that previously described with the exception that the control is so arranged that only one or a limited number of breakers may be closed at a time thus decreasing the size of storage battery required for control power. This method of control is not recommended where a.c. control is used since it has been found cheaper to provide the extra kilowatts of control power than to add the necessary interlocking devices in the control circuits.

Outgoing Distribution Feeders. Unequal Time Intervals. Any Number of Breakers Re-Closing Simultaneously

Unequal time intervals between re-closures are obtained by the use of a motor operated timer having three contact arms, set at different angles. The timer is adjusted so that a complete cycle is performed in a definite time, usually from 2 to 3 minutes. The various angles between the contact arms represent different time intervals. Once released the timer arms move in the same direction until they reach their normal position. In this manner the cycle of operation is determined by the timing device. The breaker must be stripped at suitable intervals in order to obtain the maximum number of re-closures available in one cycle of operation of the timer. As contrasted with the method of control mentioned in the two previous sections it

will be noted that in the latter methods the breaker itself determines the number of re-closures.

With the control giving unequal time intervals, the breaker is locked out if it should be opened a few seconds before the timer reaches its normal or zero position. In this manner it may miss one or even two re-closures and still be locked out after tripping the second time. Such a condition, however, is more or less remote since the overload conditions usually are of such nature as to obtain successive tripping.

Outgoing Distribution Feeders. Unequal Time Intervals, with a Limited Number of Breakers Re-Closing Simultaneously

This method of control is practically the same as that mentioned in the foregoing section and has the same features in the method of protecting the control source from overload as mentioned under the corresponding type of control with equal time intervals. Equal time intervals between re-closures take care of most requirements for industrial service, that is, mixed power and lighting load. Unequal time intervals between re-closures are provided with equipments where practice has shown that after the first re-closure the breaker will usually remain closed. For subsequent operations the interval is gradually increased so as to lessen the duty on the oil circuit breaker.

The idea of a unit design of a.c. feeder equipments has the advantages as outlined in the introduction to this section. The equipments re-establish service in a minimum time with the same degree of reliability at all hours. They permit the supplying of small load centers with a greater return in revenue than would be obtained in the case of manual operation. In the case of larger load centers this feature is more pronounced. At times it has been found advisable to operate feeders of this type by means of supervisory control so that the control and indications are obtained at one central point.

Relays and Relay Application

During the past year there has been a decided trend among the Pacific Coast central stations towards the application of modern types of relays for the purpose of sectionalizing a portion of transmission line which is short-circuited, or grounded. In large inter-connected high tension networks it is vital that the section of the network in trouble should be removed from the system before synchronous apparatus falls out of step and the whole system is split up with the resulting interruption to service. The discussions of the Apparatus Bureau on this subject were devoted largely to the result of the use of specific types on the systems and taken part in by the members representing such systems. Methods of checking relay operations, relay maintenance, and methods of keeping records of relay performances were brought out.

The use of double trip relays in place of the single trip type with the necessary auxiliary relays is apparently gaining in popularity on the Pacific Coast and one large company has adopted this type as its standard.

The use of double trip relays has the advantage in that it tends to simplify the control wiring. On the other hand, it will be necessary to determine if the double trip contacts will remain in adjustment after being in service for some time so there will be no question as to the reliable performance of this relay. Two of the large manufacturing companies are now supplying induction type relays equipped with operation indicators. This attachment, which is really an internal annunciator, will be of considerable value in analyzing relay operations and studying transmission line shorts. The Pacific Coast companies are now beginning to purchase relays equipped with this device and some are going so far as to install the operation indicator in relays already in service on their systems.

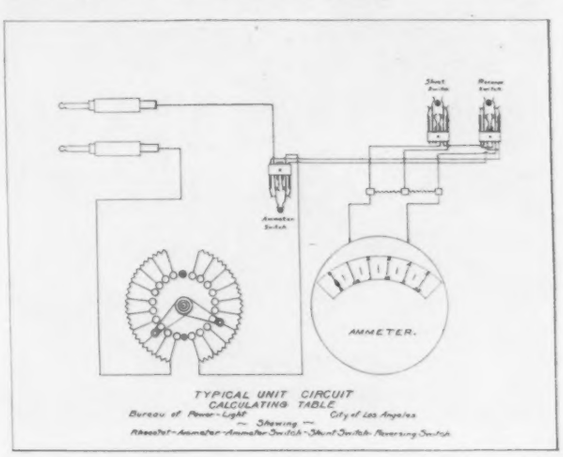
The practice of sealing relays in the same manner as integrating kw.-hr. meters are sealed is being seriously considered by some of the Pacific Coast central stations. One large company has definitely decided to put this policy into effect. It is felt that the importance of relays in isolating short circuits and minimizing system interruptions justifies that all possible means be taken to prevent any unauthorized changing of relay settings. Such settings must be based on a consideration of the system as a whole. A change of setting in a relay at a certain station without consideration of the other stations on the system can only result in faulty operation at the time of a short circuit on the system.

The successful application of relays for the purpose of clearing trouble on long transmission lines operating at the highest voltage yet attempted (220 kv.) is reported by two large California systems. The value of relays, when combined with suitable oil circuit breakers, for isolating a section of line which is suffering from a flash-over has been thoroughly proved. Before the application of relays for automatic circuit breaker operation a flash-over on an important high voltage transmission line would result in a system shutdown for a period of from one-half minute to several minutes. Since the application of relays, the only evidence of a flash-over is the automatic opening of the oil circuit breakers at each end of the section of the transmission line in trouble. The system suffers no interruption:—the only indication being a drop in voltage of about ten per cent for a period of fifteen seconds.

The impedance or distance relay which has only been on the market for a short time offers considerable promise for successful application in complicated transmission networks. One system on the Pacific Coast reports an installation covering a number of relays in a small loop, but up to this time there is very little to report covering the results obtained by their use. It is expected that there will be more installations of this type of relay on the Pacific Coast during the coming year.

The advantage of systematically reporting, tabulating and analyzing operating troubles which cause system interruptions is more apparent each year. One large company reports that the dispatching supervisor tabulates the service interruptions classified under cause and potential and from this classification the engineers concerned determine what steps to take to minimize interruptions in the future. It appears that, if possible, a standard method of reporting and exchanging information covering causes of system interruptions on the various Pacific Coast systems would accomplish much good. It might form a basis for future designs of machinery and lines and possibly suggest corrective measures in operating routine. It is believed that this subject is of sufficient importance to justify the appointment of a sub-committee of the Apparatus Bureau, Pacific Coast Electrical Association, to study the subject more thoroughly next year.

The principal work which has been undertaken by the national relay sub-committee this year has been in preparing, editing, and advance selling of the Relay



Typical unit circuit calculating table used by Bureau of Power and Light, Los Angeles, Calif.

Handbook in which the Pacific Coast members of this sub-committee have assisted. It is gratifying to note that although the allotment to the Pacific Coast was 200 copies, advance orders for approximately 350 copies have already been secured, and it appears as if 500 copies will be absorbed in this territory. The Relay Handbook will serve as the report of all the work of the National Relay Sub-Committee up to the date of publication. It "will be a complete treatise on the subject of relays, including illustrated descriptions, direct

and alternating current relay schemes, methods of trip, a study of relay current and potential transformers, calculations of short circuit values in alternating current systems, calibration, maintenance, testing, and records, with a complete bibliography."

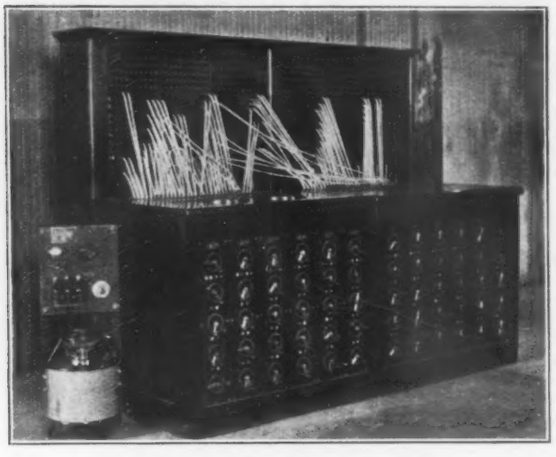
The calculation of the current flowing on a transmission network at the time of a short circuit becomes quite involved and is somewhat laborious when the system consists of more than a few generating plants, transmission lines and sub-stations. To overcome the necessity of this tedious calculation a device, known as a calculating table or board, is coming into general use throughout the country. The engineers of some of the Pacific Coast systems felt that the calculating table which had been in general use was too elaborate and, consequently, calculating tables are being devised which are less expensive and thoroughly satisfactory for the system concerned, even though they lack the flexibility of some of the other tables in use in the country. A short description of two calculating tables now in use on the Pacific Coast is included as part of this report.

Calculating Table for Calculating Short Circuit Currents on Distribution Networks as Built by Bureau of Power and Light, City of Los Angeles

Short circuit calculating tables are of two general classes—first, those which are built up of fixed values of resistance adapted for one particular system and second, those built up of adjustable resistances which may be set for any system or part thereof. After investigating the two different classes, the Bureau of Power and Light decided that inasmuch as their distribution system was changing very rapidly due to growth, the second type of table would be of much greater service to their department.

For their present system it was decided to build a sixty unit table, but so constructed that extensions could be added at any time. Following out this idea the table was divided into two sections of thirty units each, built up on individual structural steel frame work the sections being bolted together by four bolts through the angle iron. Two detachable ends were built so as to give a finished appearance and protect the interior. At any time that it is desired to increase the size of the table, one end may be detached and another section of thirty units added.

The photographs herewith show the general arrangement of the table. The resistance units are of Ward Leonard manufacture of 4,400 ohms each. They



Sixty-unit calculating table as used by the Bureau of Power and Light, Los Angeles, Calif.

are mounted in groups of five on a Micarta panel, each panel being fastened to the steel frame work independently. Each unit is divided into ten steps of 400 ohms each and ten steps of 40 ohms each, which are connected to contact buttons mounted on the front of the Micarta. Two contact levers are provided, pivoted at the center of the circle of contacts and electrically connected to each other, which short circuit any desired per cent of the rheostat. The 400-ohm sections represent 10 per cent reactance and the 40-ohm sections 1 per cent; the total rheostat thus represents 110 per cent reactance.

For the purpose of making connections between the different units, there are provided seven hundred and twenty, one-wire telephone jacks. These jacks come mounted on jack-strips of hard rubber and ten to the strip. The ten jacks on every strip are shorted together thus forming a bus. The jack-strips are laid one upon the other in vertical tiers twelve high. There are three tiers to the section or six tiers in the total table. All jacks on the bottom row of each tier are connected together across the total board and tied to the positive terminal of the motor generator. Likewise, the second row are all connected together and connected to the negative terminal of the motor generator. This leaves ten rows of ten jacks in each vertical tier, or sixty independent busses on the total table for connection purposes in setting up the net work. The terminals of each rheostat unit terminate in one-wire telephone cords equipped with one-wire plugs. These cords drop through holes in the table leaving the plugs standing vertical and are arranged in pairs along the length of the table as shown in the photograph.

Corresponding to each pair of cords there is a row of sixty telephone keys. A key is thus provided for each rheostat and its purpose is to cut an ammeter into the circuit. This is clearly shown in the accompanying wiring sketch. There is also provided a key for reversing the polarity on the ammeter. This ammeter is provided with two scales. A double-throw telephone key shifts from one scale to the other. The maximum readings of the two scales are 0.5 amperes and 0.05 amperes. Current is supplied for operating the test table by a small vertical motor generator set.

To operate the board, the distribution network it is desired to investigate is reduced to a convenient base kva., by multiplying the reactances of all generating and transforming equipment by the ratio of the chosen base kva. to the kva. capacity of the particular equipment.

Line reactances are also reduced to the base kva. by the following formula:

$$\text{Per cent Reactance} = \frac{\text{Base kva.} \times \text{Reactance (ohms)}}{(\text{kv.})^2 \times 10}$$

where kv. represents kilovolts at which the line is operated.

One terminal of all the rheostats representing generating equipment is plugged in on the positive bus, the other terminals are tied to busses to which are connected the various lines and transformers of the network under investigation. The rheostats are set to the percentage reactance (reduced to the base kva.) corresponding to the particular apparatus or line or group of lines it is intended to represent. When completed, the table represents a miniature distribution system similar to that under investigation. Ohmic resistance of the system is neglected, the reactance being represented on the calculating table by resistance. This leads to some error, giving short circuit values too high but the error is usually small and on the safe side.

To study the effect of a short circuit at any point of a system thus set up, it is only necessary to connect the point to the negative bus, then by means of the switch keys, ammeter readings may be taken on any line transformer or generator and the magnitude and direction of the current recorded. By setting the rheostat of one unit to zero, the cords to this rheostat may be used for this purpose and the total short circuit current which occurs at this point may be read on the ammeter. The current which is read on the ammeter, multiplied by a constant, gives the value of the true short circuit current that will flow in the system under investigation.

If the instantaneous reactance of the synchronous equipment (reduced to the base kva.) is used in setting the rheostats representing the generators and synchronous impedance, then

$$I_0 = \frac{(\text{Base kva.}) \times 1{,}000}{1.73 \times .025 \times E} \times i$$

where I_0 = Instantaneous amperes, effective value, symmetrical wave.

E = Line voltage.

i = Amperes as read on short circuit calculating table ammeter.

The total reactance of the system to any point of short circuit is obtained from

$$\text{Per cent Reactance} = \frac{C}{1.73\ E\ I_0}$$

where C is normal capacity of total connected synchronous apparatus.

Knowing the value of C and per cent reactance of the system to any point of short circuit, the value of short circuit current may be obtained at any time after short circuit occurs, from decrement curves as published by Messrs. Hewlett, Mahoney, and in the Burnham American Institute of Electrical Engineers Proceedings, Feb. 1918.

Thus it is possible to determine the kva. breaking capacity required on any oil switch for any time setting of the relays. The peak value of current, first half cycle, no load, unsymmetrical wave, is

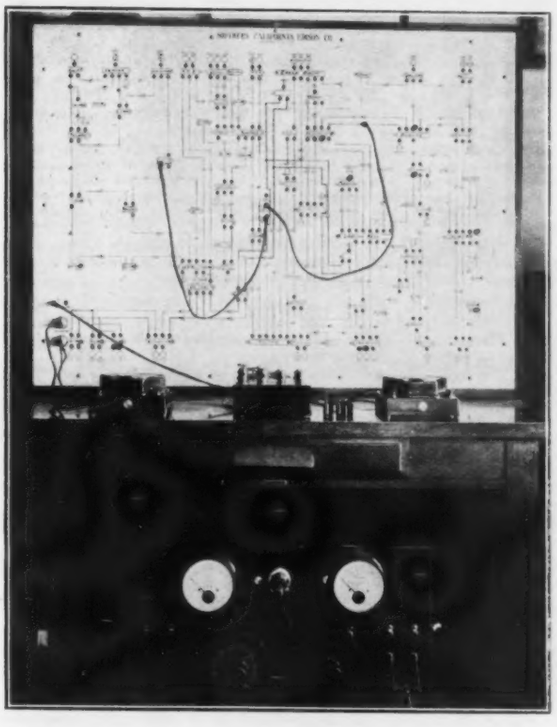
$$I_1 = 2\sqrt{2}\ I_0$$

It is the above value of current which is to be used in calculating the mechanical strain to which any apparatus is subjected at the instant of short circuit. So far the table as constructed by the Bureau of Power and Light has given perfect satisfaction and has been a great help in solving questions involving magnitude and direction of current values due to short circuit on their system.

Edison Calculating Table. Description of Equipment for Calculating the Short Circuit Current at Any Important Point on the System

The application of oil circuit breakers in the generating plants and substations of a system such as that of the Southern California Edison Company demands that the current interrupting duty of the oil circuit breaker at time of severe short circuits be definitely determined in advance. A transmission system such as this which consists of a complete network of high tension lines makes the necessary calculations exceedingly complicated.

A calculating board of the vertical type as shown in the illustration has recently been completed by the shop and is now in daily use in the protection engineering department of the Southern California Edison Company. This equipment is in the form of a cabinet in which suitable resistance units and telephone jacks are mounted and connected in the same electrical relation as the 220,000 and the 60,000-volt transmission system. The front of the cabinet is a three-ply, 4 ft. x 3 ft., wooden panel, enameled in white on which a diagram showing the powerhouses, substations, switching stations, and transmission lines is painted. These stations are placed in the most convenient diagrammatic form because a geographic arrangement of a system the size of this company would necessitate an extremely large panel in order to locate stations in congested territory.



Vertical calculating board as built and used by the Southern California Edison Company.

The reactance of each generator, transformer, and synchronous condenser was obtained from data furnished by manufacturers of this equipment and the reactance of the transmission lines was calculated from the physical characteristics of these lines. In designing the calculating board these reactances were reduced to reactance values based on 500,000 kva. When installed on the calculating board these reactance values are represented by equivalent values of resistance. Each generator, transformer, transmission line and synchronous condenser on the 220,000 and 60,000-volt system is, by this means, represented by the proper value of resistance which is connected to the adjacent resistance in the same electrical relation as the actual equipment in use on the transmission system. The resistances corresponding to the synchronous machines are connected between the network of resistances of the transmission lines and the positive bus bar while the resistances corresponding to the lines are connected to the negative bus. Means are then provided to impress a potential of 100 volts, direct current furnished by a 500-watt motor-generator set, across the negative and the positive bus bars. At each location representing a station bus and in the middle of each transmission line suitable permanent taps are brought out from the network to the front of the board. Telephone jacks, designed to be normally closed, are provided in each position corresponding to each major oil circuit-breaker on the system. Dummy plugs made of an insulating fiber can be inserted in any jack which action corresponds to opening the circuit-breaker thus cutting the piece of equipment out of service.

A short circuit is then put on the system at any point desired. This is accomplished by means of a flexible wire of negligible resistance permanently attached at one end to the negative bus. The other end is provided with a clip so that the lead may be readily attached to any of the taps at a substation bus or on a transmission line and thus produce the short circuit. A telephone plug can then be inserted in any of the telephone jacks used to represent the oil circuit-breakers on the actual transmission system and by this means the current flowing in this switch at the time of a short circuit can be determined. It is also possible to measure the total current in a short circuit on a bus and to determine in which direction the current is flowing under these conditions.

The value of current measured by the ammeter is multiplied by a constant of 500,000. This gives the instantaneous value of the short circuit in kva. In order to calculate the short circuit current at any point it is necessary to know the total synchronous capacity of the machines connected to the system and the equivalent full load current of the machines at the voltage of the line where the short is applied. Then

$$\frac{\text{Synchronous capacity} \times 100}{\text{kva. at the short}} = \text{per cent reactance.}$$

Tables are provided which give the constants for various per cent reactances which multiplied by the full load current give the short circuit current.

In a system such as this the current flow is enormout at the time of a short circuit on the bus of some of the larger substations. The following examples will give an idea of the short-circuit current possible and will also indicate the value of introducing a small time element when an oil circuit breaker is called upon to clear a short circuit:

Station	Value of Initial Current Amp.	Value of Current at the end of 0.2 Sec. Amp.	Value of Current at the end of 2.0 Sec. Amp.
Laguna Bell	22,300	12,200	9,440
Eagle Rock	17,950	10,700	8,370
L. A. No. 3	16,900	10,350	8,640
Newmark	19,400	11,350	9,120
Long Beach Steam Plant	16,300	9,950	8,200
L. A. No. 3 to MacNeil 60-kv. Line	9,870	7,150	6,530

From the above current values it can be seen that extreme care should be taken to apply circuit breakers capable of rupturing such short circuits if prompt and successful isolation of the short circuit from the system is to be accomplished.

Proposed Change in Transformer Polarity

At the present time the National Electric Light Association transformer standards provide the following:

"Standard Polarity for Single-Phase Transformers.

"The standard polarity for single-phase constant potential distribution and power transformers for lighting and power is as follows:

"Subtractive polarity shall be standard for all single-phase transformers, excepting those in sizes 200 kva. and smaller whose high voltage ratings are 7,500 volts (delta) and below, for which additive polarity shall be standard."

It has been proposed to change the present standard to a single standard of subtractive polarity for all transformers. The advocates of this proposed change point out that various advantages would result if a single standard was adopted. The central station systems on the Pacific Coast however are decidedly opposed to a change as they feel that the extent of the western systems and the number of distribution transformers in use offers a great many disadvantages to making such a change. The subject was discussed in the meetings of the Apparatus Bureau and it was the opinion of the meetings that no change in the present standard should be made. The subject is of sufficient importance however to take the matter up in detail with the operating and engineering departments of the central stations on the Pacific Coast and get an expression of opinion from this source.

The following is submitted by the transformer engineers of the General Electric Company as a supplement to a previous report on this subject.

Comparison of Transformers on Basis of Losses

In the report of the Distribution Transformer Sub-Committee of the Apparatus Committee of the Pacific Coast Electrical Association, as published in the June 1, 1923 issue of the Journal of Electricity, the attempt is made to compare three-phase and single-phase transformers by plotting a function of the product of the losses against kva. capacity. Criticism was made at the time of this particular method of comparison, but no alternative offered. It is now desired to propose a basis for plotting which is both logical and accurate, this scheme having been suggested by the transformer engineers of one of the manufacturing companies.

Both schemes recognize the product of the iron and copper losses of a given transformer as a constant, being independent of the ratio of iron and copper losses and independent of the voltage and current at which the output is secured. This product, often called in the past the "equivalent total loss" of a transformer, cannot, however, be used directly as a basis of comparison as is done in the sub-committee report referred to, for it is not only illogical but leads to unreasonable results.

For instance, plotting the per cent equivalent total loss, of various sizes of transformers as so defined, it is found that the larger the kva. rating of a machine the larger is its per cent equivalent total loss. Such a result is of course inadmissible. The larger the transformer, the smaller are its per cent losses; and if some arbitrary definition of an "equivalent total loss" makes its percentage value to increase with the size of the transformer, its appropriateness as a basis of comparison becomes questionable. However, defining the equivalent total loss as that minimum total loss at which a unit can deliver its rated kva. output (assuming the most favorable values of current and voltage), this value being approximately twice the square root of the loss product, we get an equivalent total loss which is somewhat less than the sum of the normal iron and copper losses, and its percentage value decreases with increasing size of transformer as it ought to do.

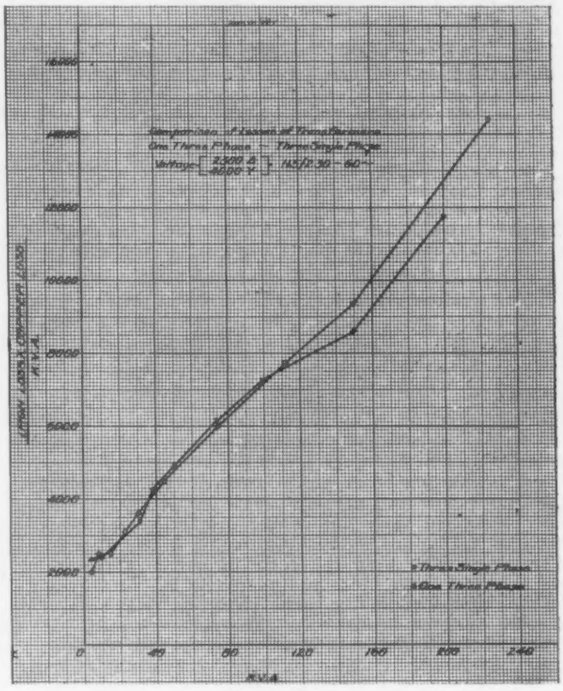
This minimum total loss combination of voltage and current exists in the same sense in which barometric readings are reduced to the basis of sea-level, regardless of whether or not the towns can actually be lowered to that level. The formula, Equivalent Total Loss $= 2\sqrt{L_i \times L^c}$, in which L_i is the iron loss and L^c is the copper loss, is an old one, and its derivation can be found in "A Treatise on Transformers" by Bohle and Robertson, page 172.

For illustration, plot the comparison of losses of 2,300/4,000-volt single-phase and three-phase transformers. Curve 1 is practically a duplicate of Fig. 2 in the sub-committee report referred to. Curve 2 plots these data in terms of per cent equivalent total loss as defined above. Comparing the information furnished by the two curves, we note the following:

CURVE I

1. Plots $L_i L^c$/kva. as a loss index or characteristic-loss for various sizes of transformers.

2. This loss index or characteristic loss does not correspond directly to any concrete physical characteristic of the transformer in which an operating engineer may be interested; not even something which the average engineer can visualize or comprehend. It is a purely mathematical quantity. For instance, for a 150-kva.



Curve I.

three-phase unit the characteristic-loss is given as about 8,600, but this is not the value of the total loss either in watts or in percentage.

3. The per cent loss index (or per cent characteristic-loss) increases with increasing size of transformers.

4. Comparing the characteristic-loss of a 150-kva. three-phase unit (which is 8,600) with that of a 150-kva. bank of three single-phase units (which is 9,300) we find that the bank of single-phase units is 8.5 per cent higher. This per cent difference, however, applies neither to the actual losses nor to the total minimum losses.

5. The loss-index or characteristic-loss is evidently a straight-line function of the apparatus size. This can apply neither to the total actual loss nor to the total minimum losses.

CURVE 2

1. Plots 0.2 $L_i L^c$/kva. as the loss-index or characteristic-loss for various sizes of transformers.

2. The loss index or characteristic-loss represents the per cent minimum total loss at which a unit or bank can deliver its rated kva. output, assuming the most favorable values of current and voltage. For instance, for a 150-kva. three-phase unit this is 1.5 per cent which is the minimum per centage total loss. The per cent total loss of such a unit at its rated voltage and current is usually somewhat higher than this, because designs are made to approximate the best efficiency not at full load but all year around.

3. The per cent loss-index (or per cent characteristic-loss) decreases with increasing size of transformer.

4. Comparing the characteristic-loss of a 150-kva. three-phase unit (which is 1.55 per cent) with that of a 150-kva. bank of three single-phase units (which is 1.6 per cent), we find that the bank of single-phase units is 3.5 per cent higher. This applies strictly to the total minimum losses of the two alternatives, and applies also approximately to their total actual losses.

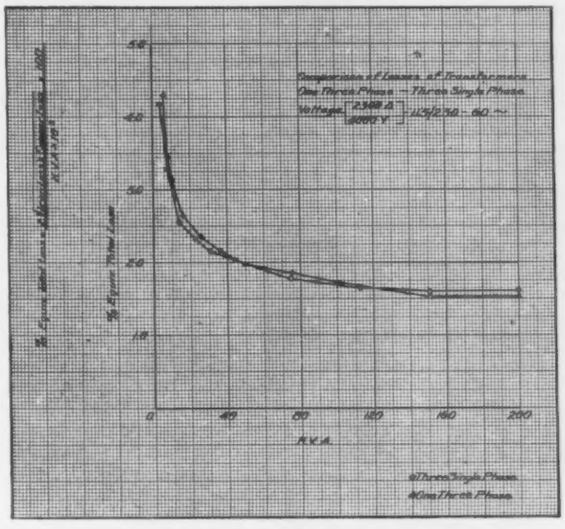
5. The loss curves are curved in accordance with the law that the per cent losses of transformers vary inversely as the fourth root of the kva. rating, assuming that the densities, space-factors, etc., are alike.

It is therefore recommended that loss comparisons be made on the basis of $2\sqrt{L_i L^c}$ for equivalent total loss in watts, or 0.2 $L_i L^c$/kva. for per cent equivalent

total loss. When convenience in plotting or extrapolating is very important, logarithmic scale plotting paper may be used.

Station Electrical Grounds

The question of the proper design and preparation of station electrical grounds for generating plants and substations is assuming more importance each day as the central station systems grow in capacity. The high values of current which must now be dissipated in the earth at the time of an accidental ground on a transmission line make necessary the installation of more elaborate grounding systems than was necessary when the systems were smaller, together with the fact that the successful operation of the extra high potential transmission lines in the West has resulted in unusual efforts



Curve II.

to install adequate grounding systems. This subject was discussed at each of the meetings of the Apparatus Bureau and a number of features of design was brought out.

The subject of grounding electrical equipment in generating plants and substations requires the consideration of three fundamental considerations.

1. That current always tends to pass from the accidentally grounded portion of the system to the generator or transformer neutral or a weaker part of one of the other phases.
2. That the current will follow the path of least resistance.
3. That the potential gradient of a conductor placed in the ground can possibly be quite pronounced when the conductor is energized.

In order to accomplish the first it is advisable and generally necessary to connect the neutrals to a ground plate or system of plates or pipes which are located at permanent moisture. When considering the second it is necessary to see that the conduits which control wiring running from the transformers and switchboard and from the switchboard to generator or synchronous condenser be shunted with heavy copper conductors. This is especially true when the neutral of a generator is grounded and it is advisable that the copper shunt be located near the conductor running between generator to transformer. When the third is taken into account it is very important to distribute copper in the earth under any parts that may be touched when a person is standing on the ground. Connections should then be made between all steel or piers near the earth's surface and the grounding system.

A network of copper constituting a grounding system serves two purposes: (1) To give the grounding system sufficient current dissipating capacity to prevent the potential of the entire substation rising to a dangerous potential between the accidental ground and the substation which would endanger life at remote points on a transmission line and (2) it tends to keep the potential of the steel structures around a substation at approximately the same potential as the surface of the soil and thus minimizes the danger of harm to a person who may be touching the steel at the time he is standing on the ground.

All of the above is a short analysis of the problem from the standpoint of the designer. From the operating standpoint it is becoming increasingly important to adopt a satisfactory means of testing electrical grounds and to make these tests periodically. More tests should be made to determine the resistance of the ground connections between various generating plants and substations on the systems in the West. The San Joaquin Light & Power Corporation has made some experiments along this line and it would be of considerable value if more work of this same nature was done on other systems.

The Apparatus Bureau suggests that a committee on grounding and the testing of electrical grounds be allowed to follow this subject up more thoroughly next year.

Electrically Operated Hydraulic Valves

By GEORGE H. BRAGG*

ONE of the numerous refinements found in modern hydroelectric developments is the remote control of important penstock valves by means of electrical apparatus. This feature has been introduced in some cases, as a safeguard to the plant; in others, as an economic convenience, while in others it is a factor in automatic operation. So reliable has the manufacturer made his product that most operating engineers now consider their plants safer with the valves remotely controlled than they were when dependence was placed in manual effort. A survey, having been made of some of the more recent installations by Pacific Coast companies, a description of a few of them will serve to point out features which make them successful.

Fig. 1 shows a wiring diagram of electrical circuits for operating three butterfly valves located at the upper ends of three penstocks. These valves can be opened or closed by a switch at the power house or by a similar one in the gate house. Energy may be supplied from either of several sources available at the power house. An overhead circuit is dedicated exclusively to this service. Indicating lights in the power house inform the operator of the position of each valve and also the presence of power at the valves. Limit switches aided by solenoid controlled brakes stop the motors when the gates are in the open and closed positions.

In Fig. 2 is shown the general arrangement of a very recent development, in which there is but one penstock and one unit. The butterfly valve is operated by a motor wired as per Fig. 3. Power is furnished from the station bank, which may be energized by the transmission line or by the unit. This valve can be operated at either of two control stations, one in the power house and the other in the valve house. Unlike that shown in Fig. 1, however, this valve can only be closed by the switch in the power house but may operated in either direction by the one in the valve house. In making this provision, it has been assumed that, in case of accident, failure or an emergency, the valve should be closed as quickly as possible by the operator but under no circumstances is it necessary or advisable to open the valve by means of the remote control.

The opening operation is never done without first equalizing the pressure on each side of the butterfly by filling the penstock through the by-pass valve. At such (infrequent) times, an attendant will be sent to the

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valve house for this purpose and also to open the main valve, which of course, he can do by manipulating the control switch. The stopping of the mechanism in this installation is done by a limit switch without the aid of a solenoid brake. Indicating lamps are omitted intentionally because they would be superfluous in this particular installation. The contactor switches are interlocked electrically to prevent both from being closed simultaneously.

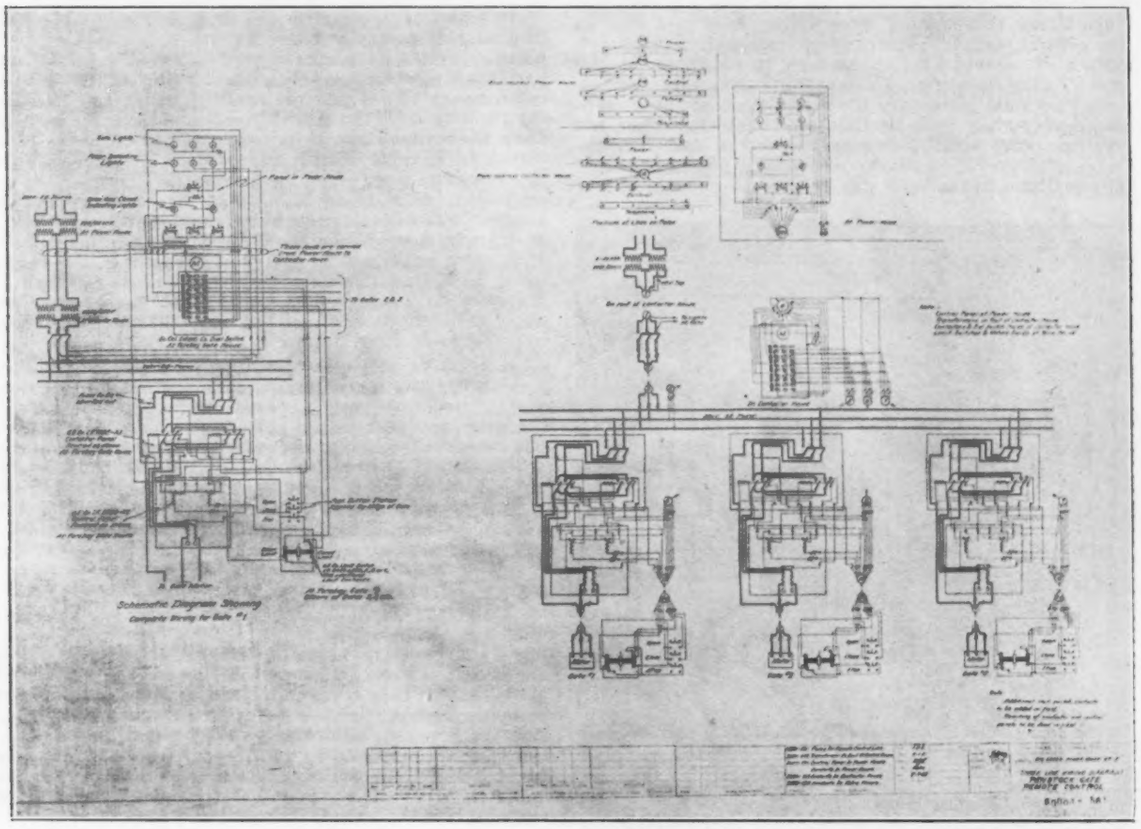


Fig. 1.—Wiring diagram showing electrical circuits for operating three butterfly valves located at the upper end of three penstocks.

The valves shown in Fig. 4 are used for a somewhat different purpose than those previously described. In this case, they are bolted to turbine scroll cases and their function is to stop the flow of water to the turbines under any emergency condition that might arise. The valves may be operated in either direction by control stations at the switchboard. It is presumed that the operator will equalize the pressure through a bypass (not shown) before opening the main valve. The mechanisms are limited in their travel in either direction by a switch actuated by small gears and a screw driven by the main gearing. This limit switch opens the contactor control circuit which energizes the motors as shown in the wiring diagram Fig. 5. Indicating lights are provided alongside of the control switches. The mechanism is equipped with hand gear to be used as a substitute for the motor drive. Each motor is direct connected through a friction clutch. This is designed to slip in case of a failure of the limit switch to stop the motor and also to disconnect the motor when the mechanism is being operated by hand.

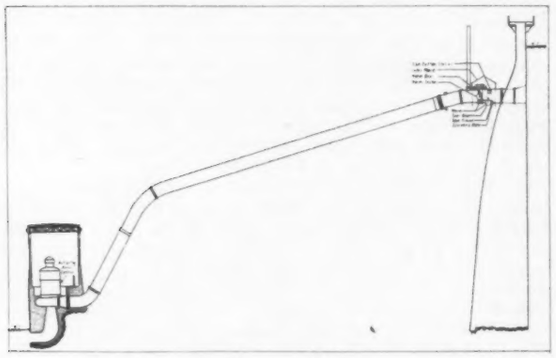


Fig. 2.—Single penstock and single unit installation.

Still another type of gate control is shown in Fig. 6. Here we have two needle valves actuated by motors connected as shown; these valves automatically regulate the quantity of water in the jets to correspond with the varying supply in the ditch. No appreciable storage is available in the forebay, which consists merely of a comparatively small header box tapped by the penstock. Constant water level over the entrance to the penstock is maintained by a float-controlled switch wired to operate the valve motors which in turn adjust the size of the opening of each nozzle. A limit switch operated through small gears stops the motors at the extreme positions of travel of the needles. Failure of the limit

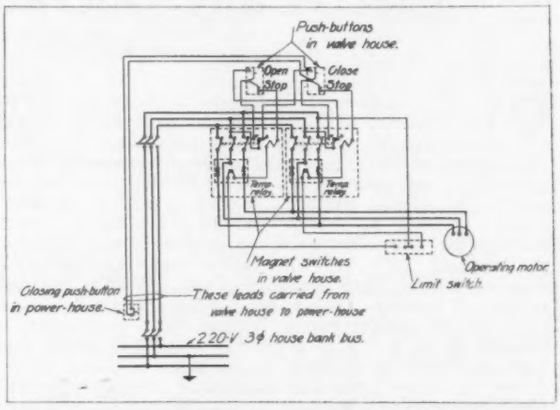


Fig. 3.—Wiring diagram for motor operated butterfly valve.

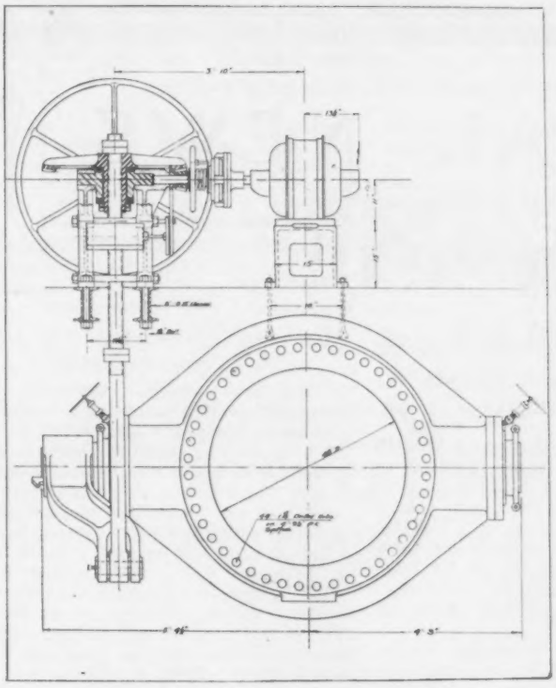


Fig. 4.—Valves bolted to turbine scroll cases and designed to stop the flow of water in emergencies.

switch to function can do no damage because the pinion on the motor shaft drives through two friction discs made of fibre. The complete wiring diagram is shown in Fig. 7.

The present practice in remote control of gate valves may therefore be summarized in the following statements:

Power Supply—Several sources of power should be supplied if possible for dependablity, especially under emergency conditions.

Control Stations—Switches should be distinctively designated and labeled plainly so they will not be mistaken by any one. The number of stations should be limited to a minimum. They should be located in most convenient places, yet accessible to the operator in any emergency. Switching combinations should be made as "fool-proof" as possible, such for instance as the omission of the "opening" control switch from the remote stations as previously described. Indicating lights in general should be provided but in some installations they can be omitted if they are of no assistance to the operator.

Control Circuits—The maximum of reliability is obtained by using lead covered conductors placed in conduit. External circuits to remote locations may be

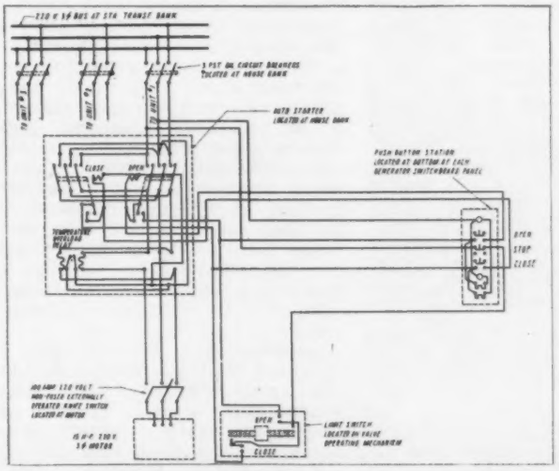


Fig. 5.—Wiring diagram for controlling emergency valve motors.

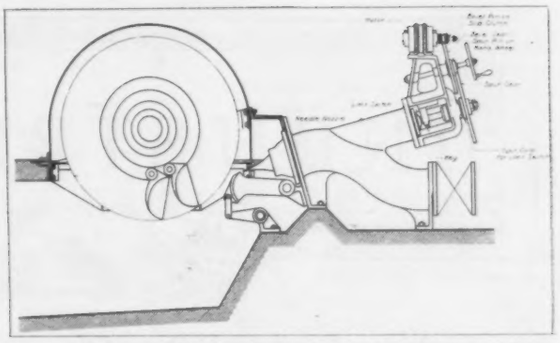


Fig. 6.—Motor-operated needle valves for automatically regulating quantity of water in jets to correspond to supply in ditch.

strung overhead but they are considered to be not so dependable. Circuits and switches should be schemed so that crossed or broken conductors cannot energize the motors or cause a mechanism to operate. No other service should be connected to the circuits intended for gate valve operation.

Auxiliaries—Motors are usually used to supply the mechanical energy although solenoids and other devices may also be employed. A manually operated mechanism is essential in all cases. It preferably should be permanently attached to the valve, but disengaged when not needed. Limit switches are important factors in the successful performance of remote control systems hence they should be substantially constructed. They should be adjustable not only for the original setting but also to compensate for wear which introduces lost motion.

To prevent damage to the mechanism should the limit switch fail to stop the motor, there should be a mechanical protection such as a friction disc drive which can slip when the torque becomes excessive. These discs are usually made of fibre and are mounted on the pinion shaft together with the adjusting spring. Temperature-actuated overload protective devices should have preference over those of the current type. If the mechanism has a tendency to coast after power has been cut off it will be found that a solenoid operated brake should be applied. As an alternative to this, the limit switch may be set to open in advance, permitting the mechanism to coast after which the hand control could be brought into action to move the valve into the exact position.

Mechanical and electrical interlocks should be employed wherever needed to make an installation "fool-proof." In this connection, it has been suggested that the control wiring for upper penstock valves should be connected through a pressure operated switch in such a manner that it would be impossible to open the valve until normal pressure exists in the penstock.

Before concluding, it should be stated that this paper has only aimed to describe several installations and to indicate some of the more important established rules of practice, and it is hoped that a free discussion will bring forth descriptions of other installations differing somewhat in type from those given and also other rules of value to those who are striving for the best ideas in the design of hydroelectric developments.

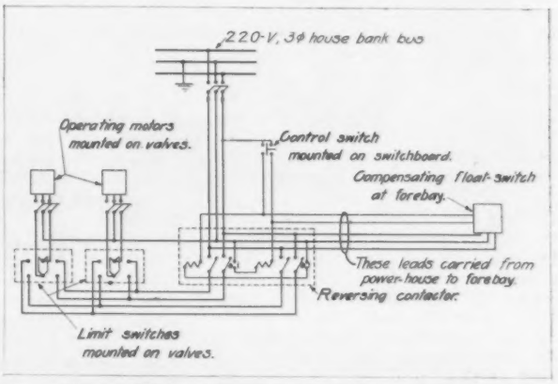

220-V, 3φ house bank bus
Operating motors mounted on valves.
Control switch mounted on switchboard.
Compensating float-switch at forebay.
These leads carried from power-house to forebay.
Reversing contactor.
Limit switches mounted on valves.

Fig. 7.—Wiring diagram for needle nozzle control.

INDUSTRIAL NEWS

Declare Fishing Rights Have Priority Over Power

Government Fisheries Representative States Priest Rapids Project Must First Provide for Fish Migration

That the federal government must recognize the rights of the fishing interests as prior to those of the applicants for power developments on the Columbia River was the declaration made by Henry J. O'Malley of the United States Bureau of Fisheries at a public hearing held in Seattle, Wash., on May 14. The conference was called to consider the application of the Washington Irrigation & Development Company for a permit to construct a 90-ft. dam at Priest Rapids. The hearing was attended by representatives from the State Fish Commissions of Washington and Oregon, from the University of Washington and from the large power companies of the Northwest. One hundred and fifty representatives of the salmon fishing and packing industry were also in attendance.

Evidencing a spirit of complete harmony, the fishing and power interests made a genuine effort to solve the impending problem of getting salmon over the 90-ft. dam to the spawning grounds in the upper Columbia. That conclusive proof a fishway could be built that would permit salmon to pass over the proposed dam will be required before the Federal Power Commission will grant a license to the applicant was the opinion advanced by Mr. O'Malley. He also stated that, as far as the Bureau of Fisheries knew, no fishway has been erected that solves the problem of taking salmon over a dam more than 40 ft. high.

The fishery interests contended that the proposed dam, by shutting off three-fifths of the spawning area, would damage the fishing industry of the Columbia River unless adequate provision was made at the dam for the salmon to make their way over it in their course to and from the upper river spawning grounds. They showed that the annual yield of the fish products from the Columbia River was $25 a surface acre, the equivalent of good agricultural land, and totaled $10,000,000.

C. E. Magnusson, dean of the College of Engineering of the University of Washington, suggested the use of elevators or escalators to take the salmon over the dam, and this suggestion was endorsed as a possible solution to the problem by M. O. Leighton of Washington, D. C., engineer for the Washington Irrigation & Development Company, who has been working with other engineers on the project for some months. John N. Cobb, dean of the College of Fisheries of the university, told of experiments that were being prepared at the university laboratories to pass young salmon through a modern type turbine to determine whether or not it would be safe to rely on this method of permitting the fish to return down stream after spawning. He also suggested that model ladders and escalators be installed at the Long Lake dam of The Washington Water Power Company in eastern Washington for experimental purposes.

Henry J. Pierce of Seattle, Wash., president of the Washington Irrigation & Development Company, stated that his company had purchased the 6,000 acres of land that will be flooded by the backwater behind the dam, and, in addition, 12,000 acres adjoining Priest Rapids for the site of an industrial city to be built there. He said that the ultimate investment involved in the project would be $100,000,000. The project plans the development of 400,000 hp. the year round, primarily for industrial uses, and an additional 250,000 hp. during the spring and summer and fall months, when the river is high, for irrigation purposes. He further stated that the utilization of 250,000 hp. is already contracted for, and that the company is negotiating with interests that will establish an aluminum plant to produce 20,000 tons of aluminum annually from eastern Washington clay. This plant will have a demand of 100,000 hp.

At the close of the Priest Rapids hearing, Chairman Sims was authorized to name a committee composed of one representative each from Washington, Oregon, the federal government, the University of Washington, and the fishing interests, to negotiate further in an attempt to solve the fishway problem.

Protest Against Dams on Baker River.—Proposed development of power sites on the Baker River in Skagit County, Wash., by the Puget Sound Power & Light Company, has been protested by Dennis Winn of the Federal Bureau of Fisheries. The company has filed on two sites on the river, one at Concrete in the Baker River canyon and the other about five miles below Baker Lake on the same river. The first unit was to be installed at Concrete with a capacity of about 45,000 hp. at an estimated cost of $500,000. The fisheries protest declared that the Concrete dam, 235 ft. in height, would totally destroy the Baker River and its tributaries as a spawning ground for chinook, sockeye, silver and steelhead salmon, as no fish ladder could be constructed which would raise salmon a greater height than 40 or 50 ft. at the most.

Municipal Ownership Sanctioned by Colorado Springs

With the heaviest vote ever cast in a special election involving a bond issue, Colorado Springs, Colo., voted on May 20 to issue $1,250,000 in bonds to erect, purchase or equip a municipal light and power plant in that city. In the election 3,178 persons voted for the bonds and 2,294 against them, thus giving the bond issue a majority of 884. Since Sept. 8, 1923, the Colorado Springs Light, Heat & Power Company has been operating without a franchise, as the voters of the city refused to grant an extension of the Jackson franchise at an election held about a year ago.

The fight over the bond issue just passed has been a bitter one, and toward the end the municipal ownership issue itself was lost sight of and it became more a question of politics and personalities, according to reports from the Colorado city. It is not known whether the city will build its own plant or try to purchase the Colorado Springs Light, Heat & Power Company properties.

Eleven Prizes to Be Given for June Bride Windows

Prizes aggregating $100 have been announced by the California Electrical Cooperative Campaign as awards in connection with the June Bride electrical appliance week, June 2-7. The prizes will be given to the eleven dealers in the state who present pictures of the best window displays presented during the week in connection with the June Bride campaign.

Material for trimming the windows has been sent either directly to the dealers or to the power company office in the dealer's city from which place the dealer can secure it. The window trim material includes posters suggesting "Electrical Gifts for June Brides" and a series of banners calling attention to the value of electrical appliances.

First prize to be given for the best decorated window will be $25, the other prizes will be five $10 prizes and five $5 prizes. Each dealer who enters a picture in the contest and who does not win a prize will be paid $1.50 to reimburse him for the cost of the picture. Pictures of windows displayed in the campaign must be mailed to the California Electrical Cooperative Campaign not later than June 7. The prize-winning pictures will be run in an early issue of the Journal of Electricity.

Improvements Planned for Great Northern Railroad Telegraph Lines.—The Great Northern Railroad plans to expend approximately $175,000 in improvements to its telegraph lines between the Montana-North Dakota line and Wenatchee, Wash.

California Power Situation Shows Improvement

Expect Another Critical Period in Late Summer and Early Fall When Dependence Will Be Made on Storage

The power situation in California has been considerably improved in the last two months due principally to a rather heavy rainfall in the latter part of March. All seriousness has not been removed from the situation, however, as another critical period will be faced during the late summer and early fall.

A period of possible power shortage will be faced during July, August, September and October, after the early run-off has taken place and storage water must be depended upon. By that time, however, 32,500 kw. of new steam capacity will be available. Four new units, aggregating 20,000 kw., will be in operation in the Long Beach plant of the Southern California Edison Company during July, and the steam turbine unit of 12,500-kw. capacity on the Pacific Gas and Electric system at Sacramento will be in operation by July 1. Besides this there will probably be available 6,500 kw. of hydroelectric power which the San Joaquin Light & Power Corporation has contracted to purchase from the Turlock Irrigation District and the output of an additional 25,000 kw. hydraulic unit placed in operation April 1, by the Great Western Power Company at its Caribou plant on the American River.

The problem in southern California will be largely one of supplying kilowatt-hours while in the northern part of the state it will be a question of peak load capacity. With the fullest conservation of all available energy, it is hoped that no curtailment of the use of power will be necessary during the coming few months. The engineering department of the California Railroad Commission has offered its services to the power companies and several conferences have already been held where the fullest spirit of cooperation was manifested.

The trying situation just passed through was brought about by the most serious drought southern California has witnessed in forty years. The northern part of the state has also suffered from lack of rain and snowfall. As a result of the protracted dry spell in southern California, the irrigation load during January and February created a total output on the system of the Southern California Edison Company approximately 40 per cent greater than that of the same months of the previous year. Coupled with this, the lack of rainfall failed to add the customary generating capacity formerly derived from the stream-flow plants, with the result that an acute situation was created, due to the heavy draft on storage water. Complete depletion of storage water was only averted on the system of the Southern California Edison Company by the utilization of every available source of energy. Even small isolated plants which had been abandoned and larger plants which were obsolete were pressed into service.

Interconnection with other companies made it possible to use the surplus steam capacity of such companies, and the cooperation and assistance received in this way was of the utmost value. The advantages and the flexibility of the extensive interconnected system in California were thus demonstrated. As might often occur, a shortage due to trouble or lack of capacity for some reason on one system which might otherwise compel a curtailment has been partially met by obtaining energy from other companies. During the recent shortage the Southern California Edison Company received 20,000 kw. from the San Joaquin Light & Power Corporation; 16,000 kw. from the Los Angeles Gas & Electric Company; 4,500 kw. from the San Diego Consolidated Gas & Electric Corporation; 2,000 kw. from the City of Pasadena, and 5,000 kw. from the Pacific Gas and Electric Company.

The Southern Sierras Power Company, Riverside, Calif., also experienced a shortage of water power and through the frequency changer installations at Colton and San Bernardino the Southern California Edison Company was able to supply this company with some energy and thus avoid serious curtailment on that system.

In addition to energy received from other operating companies, numerous consumer's isolated plants were rehabilitated, connected to the Edison system and operated by that organization. Seven isolated plants with a combined capacity of 5,850 kw. were placed in operation. A difficult problem was overcome in the case of one of these plants. The Vineyard plant of the Pacific Electric Railway Company, of 3,000-kw. capacity, had been idle for eleven years and parts of the equipment had been removed. In spite of this the Edison organization restored the plant to service in the remarkably short period of seventeen days. The restoring of many of these plants to service involved in some cases re-tubing of boilers, restoration of fire brick, cleaning and repairing of condensers, overhauling of electrical apparatus, installation of transformers, switches, synchronizing apparatus, and other facilities in order that the plants might be operated in parallel with the power company's system.

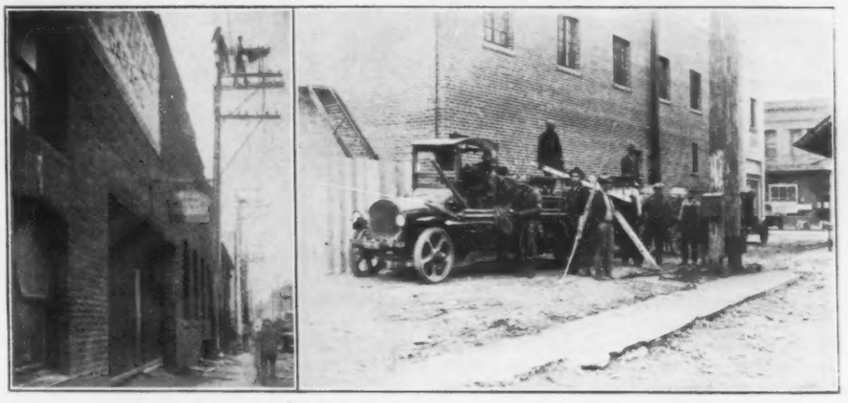
Although some apprehension was felt in the northern half of the state, the situation was not nearly so critical as that in southern California. Only a fraction of normal precipitation exists in the Sierra Nevada Mountains, but notwithstanding this fact a greater proportion of normal storage water will be available than in the southern part of the state. The large steam reserve of the Pacific Gas and Electric Company, together with a new 12,500-kw. steam turbine in the Sacramento plant which will be in operation by July 1, will help materially.

Committee Refuses to Report Ford Bill to Senate

By a vote of 10 to 6, the Senate Committee on Agriculture on May 21 refused to allow the bill embodying Henry Ford's offer for the Muscle Shoals properties of the government to go on the Senate calendar, even with an unfavorable report. No motion proposing to report the Ford bill favorably was made at this session of the committee. Had such a motion been made it probably would have been supported by not to exceed four votes. The objective of the proponents of the Ford bill at this hearing was to get the measure on the Senate calendar. They recognized that a favorable report could not be obtained.

On failing to get the Ford bill out of the committee, even with an unfavorable report, it then was moved to report Chairman Norris' government-control bill. This would have been of advantage to the Ford supporters, as the passage by the Senate of this substitute for the Ford bill would have thrown the legislation into conference. In this way many of the features of the Ford bill could be embodied in the conferees' bill. This proposal, however, was voted down 11 to 6. A motion to close the hearings immediately was lost overwhelmingly, but by a vote of 10 to 6 the committee agreed to close the public hearings on May 26 and to consider, in executive session, on the day following such final action as the committee may take.

The majority of the committee, it is believed, feels that in view of the government's $200,000,000 investment at Muscle Shoals the best course to pursue is government operation of the dam and its power house. In that connection, it has been suggested that contracts for power, for a time at least, be for relatively short periods until actual operation may have demonstrated the terms and conditions under which the public's interest will be served best.



Over a period of fourteen months line crews of the San Joaquin Light & Power Corporation have been rebuilding many of the distribution lines of the company, to conform with the California Railroad Commission General Order No. 64. Wing-arm type of construction is being installed to insure more adequate service and to secure greater safety to those engaged in working on the lines. Longer and heavier poles are also being placed.

Association Opens Campaign to Defeat Bone Bill

Unique Pamphlet Presents Arguments Showing Why Washington Public Ownership Measure Should Be Rejected

Power and light companies of the Northwest have opened a campaign to defeat the passage of the proposed "Bone Power Bill," which, if the efforts of the so-called Washington Superpower League to obtain sufficient signatures to the petition are successful, will appear on the ballot in the Washington general election, Nov. 4, 1924, as Initiative Measure No. 52. The text of the proposed measure follows.

"AN ACT

"Authorizing cities and towns to use, purchase, sell and dispose of electric current inside or outside their corporate limits; to acquire, construct, maintain and operate inter-tie lines, transmission lines and distribution systems; and to exercise the right of eminent domain in aid of the acquisition, construction, repair, operation, extension or betterment of any plant or system for generating, transmitting or distributing electricity.

"BE IT ENACTED BY THE PEOPLE OF THE STATE OF WASHINGTON:

"Section 1. Any city or town shall have the right to sell and dispose of electric current to any other city or town, governmental agency or municipal corporation, or to any person, firm or corporation, inside or outside its corporate limits, and to purchase electric current therefrom. No such purchase or sale of electric current shall subject or make liable any city or town, or any other purchaser or seller of such electric current, to any tax on account of such purchase or sale.

"Section 2. Any city or town is hereby authorized to acquire, construct, purchase, condemn and purchase, own, operate, control, add to and maintain, electric generating plants, lands, easements, rights, rights-of-way, franchises, distribution systems, substations, intertie or transmission lines, to enable it to use, purchase, sell and dispose of electric current inside or outside its corporate limits, or to connect its plant with any other electric plant or system, or to connect parts of its own electric system.

"Section 3. Whenever in aid of the work of construction, repair, operation, extension or betterment of any electric plant or system of any city or town, or in aid of the work of logging or clearing a reservoir or impounding site therefor, the owner, lessee or operator of any railroad not a common carrier, shall refuse, for a reasonable consideration to be mutually agreed upon, to transport any materials, machinery, equipment, logs, timber products, supplies or labor, to or from the place or places on said railroad nearest or most convenient to the point or points where such work of construction, repair, operation, extension or betterment, or such work of clearing or logging in such reservoir or impounding site, is being done or performed; or whenever the owner, lessee or operator of any booming, rafting or sorting works, shall refuse, for a reasonable consideration to be mutually agreed upon, to boom, raft or sort, any logs, or lumber products, removed or to be removed by or under the direction of such city or town, from any lands used in such work, then and in that event such city or town shall be and is hereby empowered to acquire by condemnation, the right to use and damage such railroad, and sufficient of its equipment, and such booming, rafting or sorting works, for such time as shall be deemed reasonably necessary by such city or town to accomplish such work, after just compensation has been first made or paid into court for such owner, operator or lessee.

"Section 4. Any city or town is hereby authorized to exercise the power of eminent domain hereby granted, under the same provisions and procedure as is or shall be provided by law for the condemnation of private property for any of the corporate uses or purposes of such city or town. In exercising the power of eminent domain for the public purposes herein enumerated or specified, by such city or town, it shall not be a defense or an objection thereto that a portion of the electric current generated or sold by such city or town will be applied to private purposes, provided the principal uses intended are public.

"Section 5. Nothing in this act shall authorize or entitle any city or town to acquire by eminent domain any electric plant or any part of such utility now or hereafter owned by any other city, town or municipal corporation.

"Section 6. If any part of this act shall be adjudged to be invalid or unconstitutional, such adjudication of invalidity or unconstitutionality shall not affect the validity or constitutionality of the act as a whole, or of any part thereof not adjudged invalid or unconstitutional. The provisions of this act shall be cumulative, and nothing herein contained shall abridge or limit the powers of cities or towns under existing laws."

In a unique pamphlet prepared and distributed by the Northwest Electric Light and Power Association, the probable effects of this measure are discussed. Quoting from the pamphlet:

"The Washington State Superpower League is planning to put over two power measures. They were drawn by Homer T. Bone, Oliver T. Erickson and Seattle public ownership advocates.

"The Bone Bill is avowedly the first step in this program (the ultimate ownership by the municipalities of the state of all the properties of the private power companies). Under pretense of merely permitting cities owning municipal plants to sell their current outside the city limits, the Bone Bill embodies the vital principles of the Erickson scheme. In order to permit cities to take over the light and power properties of existing companies, Mr. Bone has added Sections 2 and 4 to the bill introduced by him in the Legislature."

Discussing the effect of the proposed bill on taxes, the pamphlet says:

"The electric light and power properties in the State of Washington are now paying over $5,000 a day—over two million dollars a year—in taxes.

"Unless prevented by these proposed bills, they will spend, within the next ten years, over one hundred and twenty-five million dollars in extending their plants and service to communities not now receiving electric energy. All under state regulation. Every dollar of this money will go upon the tax rolls to lighten your burden of taxation."

The pamphlet then goes on to show that the removal from the tax rolls of the present properties of the private companies by the purchase of them by municipalities, will increase the tax burden generally over the entire state.

In discussing the bill's effect on electric rates, the pamphlet has this to say:

"Proponents of the Bone-Erickson bills would bond the state for approximately three hundred million dollars, would take all electric light and power properties off the tax rolls and turn them over to political management and operation, all upon vague and indefinite promises of reducing the price of the cheapest item upon the family budget."

In attacking the claim of the municipal ownership proponents that rates in Seattle have been forced down by the municipal plant, the pamphlet makes the following comparison of electric bills in different cities, in the case of the average monthly consumption of 36 kw-hr. for household use:

"Seattle

36 kw-hr. @ 5½c.....$1.98

Spokane

First 20 kw-hr. @ 7c.....$1.40
Next 16 kw-hr. @ 3c..... .48

His bill in Portland would be $1.97. Rates are practically the same in all three cities, although neither Spokane nor Portland has a municipal plant."

Calling attention to the fact that municipal operation of public utilities is unregulated, and showing the possible effects of this lack of regulation on outlying districts, the pamphlet continues:

"Municipal plants are exempt from regulation. As originally drafted, the Bone Bill merely gave municipalities the right to sell electric energy outside their city limits, and the claim was vigorously made that its purpose was to enable them to compete with the private companies in outside territory. With the addition of the Erickson features as contained in Sections 2 and 4, they would be empowered to either purchase or condemn all existing light and power properties in this outside territory so as to obtain exclusive control of the business. When this is accomplished, these cities will absolutely dictate the rates for all outlying cities and communities."

Quoting further from the pamphlet, reasons are given,

"Why the Taxpayers Should Look This 'Gift Horse' in the Mouth.—The Bone-Erickson 'free' power bill is traveling under a fraudulent label. The only thing 'free' about it is the power of the political machine to dip into the taxpayer's pocket-book. Nor does this bill contain any assurance of 'cheap power' to anybody.

Cheap power results from well conceived projects, wisely and economically developed and efficiently administered. Inaccurate engineering estimates, overambitious schemes and extravagant political management will inevitably result in higher, not lower, rates."

Farther along the pamphlet makes this comprehensive observation:

"Initiative Measure No. 52, the so-called Bone Bill, does not contain one single provision which insures in the slightest degree the conservation of the

water powers of the state **in the interests of the people of the state.** Its purpose is to allow Seattle and Tacoma to still further extend their experiments in municipal ownership—to use still more of the state's waters without compensation—to obtain an unregulated monopoly of the light and power business—to issue more tax exempt bonds—to create still more tax exempt property, and to still further increase the tax burden."

It concludes by advising its readers to—

"**Read the Bone Bill.** Study its provisions carefully, with particular reference to its effect upon **your taxes** when the present tax-paying properties are removed from the tax rolls."

Puget Sound Property Seized in Tax Payment Battle

Seizure of over two million dollars' worth of personal property of the Puget Sound Power & Light Company in Seattle, Wash., was made by Matt Starwich, sheriff of King County, on May 23. Notice of distraint and sale was served upon officials of the company, to secure the payment of over six hundred and fifty thousand dollars in taxes and interest accruing from the 1919 tax on the Seattle street railway, which was sold to the City of Seattle on April 1, 1919. Simultaneously with the serving of the notice of seizure on A. W. Leonard, president of the company, deputies posted notices of sheriff's sale, dated June 10, on the property distrained.

In an effort to stay confiscation and sale of the property by the King County sheriff, the Puget Sound Power & Light Company filed suit in the Federal court of equity, asking for a temporary restraining injunction until after a hearing on May 28. The suit charges the city and county officials with being fraudulent and oppressive. No action on this suit had been taken up to the time of going to press.

The King County sheriff seized the property on the order of Wm. W. Shields, treasurer of the county, who is demanding the payment of the 1919 taxes, together with the interest on them since March 15, 1920. The original amount of the tax bill was slightly over $400,000 and this, together with the interest at 15 per cent per annum makes the total amount demanded.

The city bought the present municipal railway system from the company in 1919 under an agreement that if the courts held assessments for that year valid, the city would pay three-fourths and the company one-fourth of the tax. The courts have since so held and the city, according to newspaper reports, has refused to pay any part of the tax, contending that municipally owned properties are not subject to taxation.

The question of liability for the 1919 tax, so far as the county is concerned, has been fought through to the United States Supreme Court and the county officials claim that the courts have invariably held that the county can collect from the company, regardless of any agreement as to tax payment that was included in the sale contract between the company and the city.

Following the recent decision of the United States Supreme Court upholding the contention of the county, the Puget Sound Power & Light Company offered to remit its share of the 1919 taxes to the King County treasurer who has refused this payment on the ground that he cannot lawfully accept only a portion of the tax. Corporation Counsel Thomas J. L. Kennedy has reported to the Seattle city council that the council cannot legally draw upon the general funds or the city railway funds to make up its share of the tax payment.

According to J. N. Howe, counsel for Puget Sound Power & Light Company, the city admits making contract to pay three-fourths of the taxes and by its ordinance, described the form of contract with such provisions. The Supreme Court decided that the contract, as prescribed, was valid and that when the city claimed the property was exempt from taxation it took the property subject to taxes and that the property was not exempt. The city now for the first time denies liability, claiming it could not make such promise and refuses to pay.

Tunnel Construction Started by Los Angeles Railway

Construction work on a double track tunnel to be 4 225 ft. long has been started by the Pacific Electric Railway of Los Angeles, Calif. The new tunnel will provide a more direct route for the Pacific Electric Railway cars from the business district of Los Angeles to Hollywood and will also avoid running the cars through the congested streets of the city. The total cost of the project is to be about three and one-half million dollars. Contract for driving the tunnel has been awarded to Twohy Brothers.

The downtown end of the tunnel is in the railway company's present Hill Street terminal and in going through the hill the tunnel will curve to the north so as to come out at Glendale Boulevard and First Street. The tunnel is to take more than 1,000 trains per day from the congested streets of the business district, providing them with a shorter route over which they can operate at a speed of 30 to 35 m.p.h. to a connection with the Glendale Boulevard lines of the company, whence comparatively good time can be made to Hollywood, Glendale and other outlying portions of the city.

The tunnel is to be lined with concrete and will have an inside width of 28 ft. and will have approach cuts 300 and 500 ft. long. Construction work on the tunnel is to be completed within eighteen months.

Campaign for Bone Power Bill Is Opened in Seattle

With Homer T. Bone of Tacoma, Wash., Farmer-Labor member of the State Legislature of Washington, and author of the Bone Power Bill, heading the movement, the campaign for the Bone Bill has been opened in Seattle. A conference and mass meeting held recently was addressed by J. D. Ross, superintendent of lighting in Seattle and chairman of the campaign committee.

The Central Labor Council, backing the bill, has asked the unions affiliated with the Council to aid in support of the measure by donations of from $10 to $25 to aid in the drive for signatures to the petitions now in circulation. The King County Democratic Club has announced that it is standing 100 per cent behind the Bone Bill.

Ishi Pishi Permits Are Granted by California Board

Six permits for water for power development on California rivers were issued during April by the Division of Water Rights of the California Department of Public Works. Five of these cover major projects.

Two of the permits are for the Ishi Pishi project of the Electro Metals Company, San Francisco, on the Klamath River in Humboldt County. The first grants to the company 3,075 sec.-ft. of water to develop 32,727 hp., and the second grants 3,000 sec.-ft. and 89,655 acre-feet per annum for the development of 103,295 hp. The estimated cost of the latter project is given as $8,000,000. These permits constitute the second step in the progress of this development, the first being the granting last July to the company of the certificate of diligence, which is involved in litigation by the State Fish and Game Commission, which claims that the development will be a menace to the fish in the river. Bearing on this matter is the report that an initiative petition is to be circulated to create a law prohibiting all power projects on the Klamath River.

A third permit for power on the Klamath River in Humboldt County was that issued to H. L. Jackman, Eureka, for 9,000 sec.-ft. for developing 92,045 hp. The estimated cost of this project is placed at $9,000,000.

Other permits issued were those to the Turlock Irrigation District, Turlock, for 1,725 sec.-ft. of water from the Tuolumne River, Stanislaus County, for 22,543 hp.; to the Modesto Irrigation District, Modesto, for utilizing 1,500 sec.-ft. of water from the Tuolumne River, Stanislaus County, for developing 19,210 hp.; and to the Mt. Shasta Power Corporation, San Francisco, for 25 sec.-ft. from Rock Creek, Shasta County, to be used in developing 889 hp.

During the same month four applications for development of hydroelectric power were received by the department as follows: from the Little Rock Power & Water Company, Los Angeles, for 50 sec.-ft. and 7,547 acre-feet of water from Little Rock Creek, Los Angeles County, to develop 6,081 hp.; two from E. B. Perrin, Los Angeles, one for 50 sec.-ft. and 12,000 acre-feet to develop 5,823 hp., and the other for 150 sec.-ft. and 20,000 acre-feet to develop 27,272 hp., both from Thoms Creek, Tehama County; and from the Bear River Power Company, Auburn, for 250 sec.-ft. and 100,000 acre-feet of water from Bear River to develop 42,994 hp.

San Joaquin Company Publishes History in Year Book

The San Joaquin Light & Power Corporation, Fresno, Calif., has recently published its Year Book for 1923. The booklet, which is presented in a most attractive form, contains a history of the San Joaqnin company, giving in a brief way the important points in the company's growth since 1896, when the first hydroelectric plant was constructed by the company's engineers on the San Joaquin River.

Illustrations showing both interior and exterior of the new San Joaquin building in Fresno accompany editorial matter describing the building in detail.

Meetings

Tentative P.C.E.A Convention Program Is Announced

The tentative program for the eighth annual convention of the Pacific Coast Electrical Association, to be held at Coronado, Calif., June 16-20, has been announced. The feature of the convention will be the Public Service Conference to be held on the afternoon of June 20. R. H. Ballard, vice-president and general manager of the Southern California Edison Company, will preside at the conference.

Information concerning hotel accommodations at Coronado, Calif., has been sent to all members of the Pacific Coast Electrical Association by Alfred May, chairman of the hotel committee. Rates for both the Hotel del Coronado and Coronado tent city are included in the information sent to the members of the association, together with a return postcard permitting the members to inform the hotel committee what space they desire to have reserved for them.

The personnel of the convention committee, as well as of the regular committees of the association, have been announced in the last issue of the Electrifier. The tentative program for the convention is as follows:

Monday, June 16

Afternoon

Registration.

Evening

Informal dancing and entertainment.

Tuesday, June 17

Morning

8:00 a.m. to 9:45 a.m.—
Registration.

10:00 a.m.—
General business meetings.
Address of Welcome.
President's report.
General Committee reports.
Report of the Nominating Committee.
Election of Officers.

12:00 Noon.—
Luncheon.
Under the auspices of The Electric Club of San Diego the electric clubs of California will provide a special program for the delegates and guests attending the convention.

Afternoon

2:00 p.m. to 5:30 p.m.—
Business sessions of the Commercial, Technical, Purchasing and Stores Sections.
Reports, papers and discussions.

Evening

9:00 p.m. to 9:30 p.m.—
Reception to President and executive officials of the Association.

9:30 p.m.—
Dancing.

Wednesday, June 18

Morning

9:30 a.m. to 12 M.—
Business sessions of Commercial, Technical, Purchasing and Stores, Accounting and Publicity Sections.

10:00 a.m. to 12 M.—
Meeting of women delegates under the auspices of the Women's Affairs Section of the Public Relations Committee—Miss J. Frances Emans, presiding.

Afternoon

2:00 p.m. to 5:30 p.m.—
Business sessions of Commercial, Technical, Purchasing and Stores, Accounting, Publicity and Personnel Sections.

Thursday, June 19

Morning

9:00 a.m. to 12 M.—
Business sessions of Commercial, Technical, Publicity, Purchasing and Stores Sections.

9:00 a.m. to 10:00 a.m.—
Meeting of the Executive Committee.

10:00 a.m. to 12 M.—
Special session of the Public Relations Section.

Afternoon

1:00 p.m.—
Sports Committee will provide delegates with an opportunity to enjoy competition in golf, tennis and swimming. Special prizes for all events. All entrants to these various events must register with the Sports Committee.

Evening

9:00 p.m.—
Grand Ball (formal) with special features; ballroom Hotel del Coronado.

Friday, June 20

Morning

10:00 a.m.—
General business session and conference addressed by national representatives.
Transaction of all unfinished business.

12 Noon.—
Convention photograph.

Afternoon

2:00 p.m.—
Public Service Conference, R. H. Ballard, presiding.
Addresses by representatives of the important public service companies in California, including power generation, transportation, communication and other allied industries.

Evening

7:00 p.m. to 9:30 p.m.—
Convention Banquet, main dining room, Hotel del Coronado; A. Emory Wishon, toastmaster.

10:00 p.m.—Convention Carnival.

Jobbers to Hold July Meeting at Del Monte, Calif.

The next quarterly meeting of the Pacific Coast Electrical Supply Jobbers' Association will be held at Del Monte, Calif., July 24 to 26. The meeting was originally scheduled for June 12 to 14, and was to have been held at Coronado.

Closed meetings will be held on July 24 and 25, and the customary open meeting will be held on the morning of July 26.

COMING EVENTS

American Association of Engineers—
San Francisco, Calif.
June 11-13, 1924

Pacific Coast Electrical Supply Jobbers' Association—
Quarterly Meeting—Del Monte, Calif.
July 24-26, 1924

Pacific Coast Electrical Association—
Annual Meeting—Coronado, Calif.
June 16-20, 1924

Wyoming Public Utilities Association—
Annual Convention—Casper, Wyo.
June 23-24, 1924

Northwest Electric Light and Power Association
Annual Convention—Gearhart, Ore.
June 25-27, 1924

Lakeside Plant Will Not Be Ready Until Nov. 1.—The Lakeside plant of the Public Service Company of Colorado will not be placed in operation before Nov. 1, 1924, according to recent announcements of the utility company. It was originally planned to place a $12,000,000 power plant in operation about July 1 of this year, but delay in the arrival of machinery has held up the work so that it will not be possible to complete the project on the original date. The first unit, which is being constructed at the present time, will cost $4,000,000 and is to have a capacity of approximately 20,000 kw. The plant is located at Boulder Lake, four miles east of Boulder, and transmission lines are being constructed to Denver and to northern Colorado points.

Seven Western Men Will Attend World Power Conference

Seven Western men have signified their intention of attending the World Power Conference, to be held in London, England, June 30-July 12, 1924. The program for the conference that is under the control of the American Committee has been announced and three papers will be presented by engineers living in the West.

The papers to be presented by the Western men are as follows:

"Regional Review for the Pacific Coast States," by A. H. Markwart, vice-president, Pacific Gas and Electric Company, and H. A. Barre, executive engineer, Southern California Edison Company; "Power Connected with Irrigation," by Henry J. Pierce, president, Washington Irrigation & Development Company, and E. C. Bebb, hydraulic engineer, Federal Power Commission; and a paper on "High Tension Transmission," by F. G. Baum, consulting engineer, San Francisco. Among the Western men that have intimated that they will attend the conference are: Prof. C. L. Cory, University of California, Berkeley; H. T. Cory, Palos Verdes Project, Redondo Beach, Calif.; W. A. Doble, chief engineer, Pelton Water Wheel Company, San Francisco; John B. Miller, president, Southern California Edison Company; R. A. Millikan, director, Norman Bridge Laboratory of Physics, California Institute of Technology, Pasadena; Robert Sibley, vice-president, American Society of Mechanical Engineers, Berkeley, Calif.; A. B. West, president, Southern Sierras Power Company, Riverside, Calif.

Telephone Operation Explained to San Diego Clubmen

"The Big Idea" in telephone operation was made the feature of the May 13 meeting of the San Diego (Calif.) Electric Club, held at the Point Loma Country Club. C. A. Stevens, of the telephone company, and chairman of the Better Telephone Company Co-operation committee of the Electric Club, was in charge of the program, given for the entertainment and instruction of the Electric Club members and their wives.

A demonstration switchboard showing both the manual and automatic switchboard operations was used as the basis for the program. Miss Dorothy McDonald, instructor of the operator's school, gave a description of the various stages of operation between the making of a phone call and its completion.

A short skit, "Ten Minutes from Broadway," depicting two married couples and their attempts to get each other over the telephone, making all the common mistakes for which service is usually blamed, concluded the program. The latter drew much comment as an excellent method of acquainting the public with some of the intricacies of telephone operation.

Radio Engineer Addresses Oakland Club.—Don Lippincott, radio engineer of the Magnavox Company of Oakland, Calif., and chairman of the educational committee of the Pacific Radio Trades Association, was the principal speaker at the May 19 meeting of the Electric Club of Oakland. Mr. Lippincott gave an interesting review of his experiences in radio work.

Manufacturer, Dealer and Jobber Activities

Century Electric Company, St. Louis, Mo., has published Bulletin No. 36, covering the Century line of a.c. and d.c. fans. The bulletin contains complete descriptions of the company's line of fans together with assembly diagrams of ceiling fans.

Automatic Electric Heater Company, Warren, Pa., is now manufacturing the Clark Selective Load Control, which is designed to provide a more even load factor for domestic installations where electric range and water heater are in use. The device is so designed that when the electric range is in use, the electric water heater is automatically cut off the line, staying off until such a time as the demand from other devices is lowered to a predetermined point.

The R. Thomas & Sons Company, East Liverpool, Ohio, has just issued an attractive folder on cemented type suspension units.

The Providence Insulated Wire Company, Providence, R. I., has taken over the insulated wire department of the Bourn Rubber Company of that city.

Apparatus is being installed in the million-volt test laboratory of the California Institute of Technology at Pasadena, Calif. Four 250,000-volt transformers, with a capacity of 1,000 kw., have arrived and are being set up. The laboratory, the first of its kind in the West, was made possible through the cooperation of the college and the Southern California Edison Company. The power company erected the building and the school is supplying the equipment. Dr. Robert A. Millikan will be in charge of the experimental work.

The General Electric Company line of oil-filled instrument transformers is being redesigned to allow the use of the same type of coil and winding now used in the distribution type of transformer. The new design will also include the interchangeable bushing now used in General Electric oil switches, distribution transformers and lightning arresters.

Moe-Bridges Company, Milwaukee, Wis., has appointed the B & R Electrical Supply Company of Denver, Colo., distributors of the line in the Rocky Mountain region.

The Electric Agencies Company, 56 Natoma Street, San Francisco, Calif., has moved to 655 Minna Street, that city, and will be located at the new address on and after May 1. B. A. Wagner, manager of the company, has just returned from an extensive trip to eastern factories.

The O. C. White Company, Worcester, Mass., has recently published two "Applied Illumination" folders that are designed to supplement the company's latest catalog. One of these is entitled "The Trend of Industrial Lighting" and is devoted to shop fixtures and shows new styles of 23D and 24D drafting-board fixtures. The other folder, on "The Factors of Lighting Efficiency," details the new 2LA conduit fixture and the new 3SA bench light. The folders can be obtained on application to the manufacturer.

The Westinghouse Electric & Manufacturing Company has recently issued a new 20-page publication, known as circular No. 1670 and entitled "Static Condensers for Power Factor Correction." In this circular the need for power factor correction and the methods of obtaining high power factor are discussed. The method of selecting the proper corrective device for power factor is carefully analyzed, and the fields of application of synchronic and static condensers set forth in diagrammatic form. A complete illustrated description of Westinghouse Type LD static condensers with wiring diagrams for two and three-phase equipment is included in the circular. The method of calculating the corrective kva. necessary for an installation of condensers and a chart for determining the per cent of reactive kva. required to raise the power factor to a desired value are next presented. A tabulation of the weights, dimensions and losses of static condensers and the weights and dimensions of transformers conclude the information given.

The Lovell Manufacturing Company, Erie, Pa., has recently placed on the market a new portable electric clothes wringer designed for use with washing machines not provided with power wringers and as an auxiliary in laundry equipment for homes, hotels, clubs, schools, etc. As the wringer is mounted on a tripod, it has a swivel hanging permitting it to be swung to any position over a washer or stationary tub. For permanent use on stationary tubs or boilers, the wringer is built without the stand and provided with clamps to hold it in place. Power for turning the rolls of the wringer is supplied by a Westinghouse heavy duty electric motor built for operation on either direct or alternating current at 110 volts.

Commercial Electric Company, San Francisco, has moved to 1925 Howard Street in that city.

Henry D. Sears, general sales agent for Webber wiring devices with offices in Boston, Mass., has recently issued a wall poster devoted to illustrations and descriptions of Staylit. The device is a lamp socket designed to keep a lamp lighted for a minute or two after the cord controlling it has been pulled.

Birkel & LeGassick, wholesale electric supply company, is developing a large business at Santa Monica, Calif. The company is located at 702 Santa Monica Blvd.

Harvey Hubbell, Inc., Bridgeport, Conn., has recently placed on the market a new toggle switch. The company has also announced a line of 10 and 20-amp. polarized shallow flush receptacles which have been re-designed to fit standard convenience outlet face plates. The receptacles are only 1-3/32 in. deep and are therefore suitable for thin partitions.

Atlantic-Pacific Agencies Corporation, San Francisco, has established sales agencies in Chicago, Philadelphia, Pittsburgh, Boston, New York City, St. Louis and Dallas, Texas.

The American Airdry Corporation has recently moved its head offices and factory from Groton, N. Y., to Chicago, Ill. The company manufactures Airdry, "The Electric Towel," and has moved to Chicago to secure a more centrally located distributing point. Pacific Coast representation for the company remains the same and is in charge of the Airdry Electric Service Company, with headquarters in the Rialto Bldg., San Francisco.

The Electric Outlet Company, Inc., New York, N. Y., has brought out a new product which will be called "wire-nuts." The new device is made of brass and Bakelite and is for use in making wire joints in outlet boxes and elsewhere.

Curtis Lighting, Inc., has moved its Los Angeles office from the Pacific Finance Building to 1040 Merchants National Bank Building in the same city. The company has recently opened a lighting studio at the new address.

The F. W. Wakefield Brass Company, Vermillion, Ohio, Ivanhoe Works of The Miller Company, Cleveland, and the National Lamp Works of the General Electric Company, are issuing a new booklet entitled "A Central Station Campaign that Sold 2,609 Store Lighting Units in 10 Days." The book tells of the experience of the Ohio Public Service Company in making 2,609 sales to 6,370 stores in seven medium-sized cities, and is designed to show other central stations and contractors how such a campaign should be conducted and as to the results that can be obtained. The information concerning the mapping out of such a better store lighting campaign is exceedingly well written and should be of value to anyone considering the possibilities of such a sales drive. Copies of the book may be obtained free of charge from any of the three manufacturers cooperating in its publication.

Gearhart Hotel, Gearhart-by-the-Sea, Ore., where the annual convention of the Northwest Electric Light and Power Association will be held, June 25-27, 1924. This hotel is reported to be the best equipped beach hostelry in the Northwest.

Personals

Franklin T. Griffth, president of the Portland Electric Power Company, Portland, Ore., has been elected president of the National Electric Light Association. Mr. Griffith is a prominent figure

FRANKLIN T. GRIFFITH

in the electrical industry in the West. In addition to his activities with the Portland Electric Power Company, which, under his direction, has shown marked progress in the relation of the utility to the consumer and in the improvement of public relations, he has been greatly interested in the subject of water power and its proper conservation and use. He was for two years chairman of the Water Power Development Committee of the National Electric Light Association, and during that time devoted much attention to the matter of the formation of the Federal Power Commission. Mr. Griffith has also been active in the interests of the Northwest Electric Light and Power Association, having served as its president at one time, in addition to acting on various committees. The new president of the National Electric Light Association was born in Minneapolis in 1870. His boyhood was spent in Oakland, Calif., where he received his education. He was admitted to the bar in Oregon in 1894, later becoming attorney for the Portland Railway, Light & Power Company, now the Portland Electric Power Company. He was elected president of that company in 1913. Mr. Griffith has been vice-president of the National Electric Light Association since the early part of 1924, having been appointed to that position to succeed the late John A. Britton. Mr. Griffith's familiarity with the affairs of the Association and his grasp of conditions in the electrical industry as a whole make him particularly fitted for his new post. **P. S. Arkwright,** president of the Georgia Railway & Power Company, Atlanta, Ga., has been elected fourth vice-president of the National Electric Light Association, and **W. A. Jones** of the Henry L. Doherty Company, New York, N. Y., treasurer.

Farley Osgood, vice-president and general manager of the Public Service Electric Company, Newark, N. J., has just been elected president of the American Institute of Electrical Engineers.

J. H. Surclaw, a director of the Canadian National Railways of New Glasgow, Nova Scotia, was a recent Los Angeles, Calif., visitor.

C. V. Schneider, of the Electrical Supply Company, Sacramento, Calif., recently made a business trip to San Francisco.

E. V. Rosenbaum, consulting engineer in the employ of the Federal Light & Traction Company of New York, has arrived in Aberdeen, Wash., to superintend the installation of the new power house equipment purchased by the Grays Harbor Railway & Light Company, at a cost of $500,000. Mr. Rosenbaum will be in Aberdeen for about nine months. He recently finished superintendence of a million dollar plant which the Federal Light & Traction Company has installed at Springfield, Mo. His work in Aberdeen will include supervision of the new power house equipment, which includes an 8,000-hp. turbine, boilers, fuel containers and conveyors, switchboards and substations.

A. S. Moody, for the past year manager of the Los Angeles, Calif., office of the general Electric Company, has been made Northwest manager of that company with headquarters at Portland, Ore. Mr. Moody has been in the service of the General Electric Company since 1907 when he became sales engineer in the San Francisco office. He was transferred to a similar position in the Seattle, Wash., branch in 1908, and in 1910 was made manager of the Portland, Ore., supply department. Ten years later he was appointed assistant manager of the Northwest territory and retained that position until he went to Los Angeles in 1923. In addition to efficiently handling his varied duties in connection with his work for the General Electric Company, Mr. Moody has taken an active part in the affairs of the electrical industry as a whole on the Pacific Coast. At one time he served as chairman of the Portland

A. S. MOODY

section of the American Institute of Electrical Engineers and was prominently identified with the activities of the Northwest Electric Light & Power Association.

Charles L. Barrett was elected a director of the Pacific Gas and Electric Company at the annual meeting of stockholders held April 8. He commenced service with the San Francisco Gas Light Company, a genealogical predecessor of the Pacific Gas and Electric Company, as assistant to the cashier, his father Wm. G. Barrett, who had been with the company in that position since 1860 or six years after the commencement of gas supply in San Francisco. In his long period of service he has held successively every office posi-

CHARLES L. BARRETT

tion, collector, bookkeeper of consumers' accounts, counterman, manager of the office force, cashier, keeper of the general books, auditor, and finally the secretaryship of the San Francisco Gas and Electric Company, the immediate operating company prior to the advent of the Pacific Gas and Electric Company, which position he has held for twenty-two years, and which period, oddly, his two predecessors Wm. G. Barrett and Joseph G. Eastland each held the position, that is to say there have been but three secretaries in the last sixty-six years of the existence of the San Francisco Gas and Electric Co. In 1906 Mr. Barrett was appointed the assistant secretary of the Pacific Gas and Electric Company which position he has continuously held since that time. His entire career has been notable for his extreme democracy and his interest in employee welfare and for his close attention to the interests of the consumer.

Norwood P. Brockett, public relations director of the Puget Sound Power & Light Company, discussed the proposed Bone power bill before the Washington State Retailers' Association in Seattle at that body's annual convention. Homer T. Bone, author of the bill, discussed the public ownership side of the question.

Charles H. Lee, formerly president of the California State Water Commission and, later, of the Division of Water Rights, has been elected president of the San Francisco, Calif., chapter of the American Association of Engineers.

K. E. Van Kuran, district manager of the Westinghouse Electric & Manufacturing Company, Los Angeles, Calif., attended the recent meeting of the advisory committee of the California Electrical Cooperative Campaign held in San Francisco on May 16 and 17.

L. M. Klauber, president of the San Diego Consolidated Gas & Electric Company, is president of the Pacific Coast Electrical Association for the year

L. M. KLAUBER

1923-1924. Under Mr. Klauber's direction the association has made notable progress during the past year.

W. L. Frost, manager, consumers' department, Southern California Edison Company, Los Angeles, Calif., attended the recent meeting of the advisory committee of the California Electrical Cooperative Campaign held in San Francisco.

Lewis A. Lewis, sales manager, and **W. H. Ude**, director of public relations, of The Washington Water Power Company, Spokane, Wash., attended the National Electric Light Association convention at Atlantic City, May 19 to 24. Mr. Lewis is chairman of the Northwest Electric Light and Power Association's electric range committee and will render a report on "Electric Range Survey" at the convention.

A. H. Biewener of the Southern Electric Company of San Diego, Calif., was a recent Los Angeles visitor.

H. C. Chappell, assistant to the general manager of the Natrona Power Company, Casper, Wyo., and secretary of the Wyoming Utilities Association, made a trip to Denver, Colo., early in April in the interest of the annual convention of the utility operators in his state. The convention will be held in the early summer.

A. E. Butler, manager of the Electrical Specialty Company, San Francisco, Calif., is making an extended trip to Eastern cities visiting various factories represented by his company in the Pacific Coast territory.

M. J. Wilkinson, for many years associated with the accounting department of the Pacific Power & Light Company, Portland, Ore., has recently been appointed assistant secretary and treasurer of that company and of the Portland Gas & Coke Company.

R. G. Gentry and **John J. Cooper**, members of the advisory board, and **S. W. Bishop**, executive member of the Electrical Cooperative League of Denver, Colo., represented that organization at the National Electric Light Association in Atlantic City, N. J.

T. A. E. Bell, Northwest engineer of the General Electric Company, Seattle, Wash., was the speaker of the day at the meeting of the Engineers' Club, Seattle, on May 15.

E. R. Greer, vice-president and general manager of the Arrow Electric Company, Hartford, Conn., and his son E. Bosworth Greer, arrived in San Francisco, Calif., May 17 on the round-the-world steamer Samaria of the Cunard line. Mr. Greer stayed on the Pacific Coast about two weeks and visited Los Angeles in company with S. H. Gregory, Pacific Coast manager of the company.

A. F. Blecksmith, district sales agent of the Duncan Electric Manufacturing Company, La Fayette, Ind., who maintains headquarters in Los Angeles, Calif, was a recent visitor to San Francisco on business for his company. While in the northern city he attended the school for meter men held at the University of California and participated as a member of the lecturing board.

H. E. Baker, for a number of years associated with the power department of the Pacific Power & Light Company at Naches, Wash., has been promoted to be superintendent of power of the Dallas-Hood River power system of that company with headquarters at Hood River, Ore. Mr. Baker at the same time assumes the duties of manager of the Hood River district, succeeding Berkeley H. Snow, resigned.

H. H. Courtright, manager of the Valley Electrical Supply Company, Fresno, Calif., attended the recent meeting of the advisory committee of the California Electrical Cooperative Campaign in San Francisco.

C. T. Uhl, formerly division sales manager for the Apex Electrical Distributing Company in the Southwest, is now district sales manager for the Pittsburgh, Pa., territory of The United Electric Company, Canton, Ohio.

Charles N. Shannon, **W. A. Guscott**, **P. Harry Byrne**, **E. C. Headrick**, and **E. A. Scott** comprise the new board of directors of the Denver, Colo., Contractors' Association, Inc. Officers will be elected from this group at an early date.

K. E. Van Kuran, manager of the Westinghouse Electric & Manufacturing Company, Los Angeles, Calif., is general convention chairman for the 1924 annual convention of the Pacific Coast Electrical Association, to be held at

K. E. VAN KURAN

Coronado, Calif., June 16-20. Under his charge have come all of the many details of the arrangements for the entire convention program.

S. H. Taylor, secretary of the Pacific Coast Electrical Association, with offices at San Francisco, Calif., is one of the pioneers of the electrical business. His

S. H. TAYLOR

connection with the industry covers a period of more than forty years of continuous service, a large part of which has been on the Pacific Coast. Mr. Taylor has contributed largely to the success of the association and of the annual convention held at Coronado, June 16-20, 1924.

H. W. Cooper, formerly manager of the Dayton-Waitsburg district of the Pacific Power & Light Company, Portland, Ore., has been promoted to be district manager at Pasco, Wash.

W. B. Wallis, president, The Pittsburgh Electric Furnace Corporation of Pittsburgh, Pa., has been visiting the principal cities of the West in connection with sales matters. On May 16 and 17 he visited Spokane, Wash., and then went to Butte, Mont. Mr. Wallis is greatly impressed with the industrial development of the western country and anticipates a great growth in the iron and steel business on the Pacific Coast during the next ten years.

Howard S. Warren, switchboard engineer of the Westinghouse Electric & Manufacturing Company of Los Angeles, Calif., recently made two trips to the Arizona and Texas districts of that company, where he was called for consultation on switchboard apparatus for mining companies in the mining region.

C. C. Langevin, of the Atlantic-Pacific Agencies Corporation, San Francisco, Calif., has just returned from an extensive trip East during which he visited among other places, Pittsburgh, Pa.; New York City; Boston, Mass.; Chicago, Ill.; St. Louis, Mo.; and Dallas, Texas.

Otto Bock, former assistant U. S. district attorney in Denver, Colo., and a prominent figure in the younger democratic circles of Colorado, has been appointed a member of the state public utilities commission to succeed the late Tully Scott.

Dr. W. M. Carr, radiologist at the Winnipeg, Man., general hospital, has been appointed radiologist at the Jubilee Hospital, Victoria, B. C., to fill the place of Dr. Warren, who has accepted a position in Los Angeles. The appointment becomes effective on June 1. Dr. Warren came to Victoria about a year ago.

Trade Outlook

San Francisco

Business conditions in San Francisco and adjacent territory, as a whole, are quiet but there is apparently no note of pessimism. Wholesale and retail trade are reported somewhat slow, manufacturing and industry fair. Dealers in specialties are enjoying good business, and sales in hardware, paints and building materials are holding up well. Some readjustment of commodity prices is noted, but no radical decline is anticipated. Buying of general merchandise continues on a conservative basis. Labor costs are steady.

Shippers of fruits, vegetables, butter and eggs are rejoicing over the 10 per cent reduction in express rates on those commodities in carload lots, ordered by the Interstate Commerce Commission and effective on or before June 21. It is estimated that this reduction will result in an annual saving of one million dollars.

The hoof and mouth disease is now believed to be under control and embargoes are being lifted, allowing fruits and vegetables to move more freely.

Building continues at an active rate, particularly home construction. The influence of the latter is reflected in the sales of home furnishings, which are reported good. An increase in the number of ships arriving and departing, with increased tonnage, is reported as compared with the first four months of last year, and a gain of about $123,100,000 in bank clearings. Collections are slow.

Los Angeles

At the recent elections over forty-five million dollars was voted for city and county bonds, covering projects which will tend to provide employment and put money in circulation in this section. The carrying of these bond issues is an indication of the healthy condition that exists in this vicinity despite the recent real estate inactivity and the foot and mouth epidemic. The latter as yet has not been done away with entirely and has adversely affected business during the past two months.

Local retail business is gradually getting into better shape, and this is particularly true in electrical lines. Radio sales are improving, though somewhat more slowly than other electrical appliances, and wholesale business is in a much better condition than over a month ago. Manufacturers continue to report excellent trade prevailing in their branch of the industry.

Wholesale merchants report trade good, and an increase of about five per cent over business in April is claimed in the grocery lines. Collections are fair.

Portland

Conditions in Portland and vicinity show no marked change during the past two weeks, although there has been some falling off in retail buying probably due to usual summer idleness. It is difficult to determine to what extent business is being affected by conditions in California due to the hoof and mouth disease. However, prices of citrus fruits, meats and green vegetables have gone up, and the influence of the epidemic is undoubtedly being felt by the railroads and dependent industries, as freight and tourist traffic is below that anticipated.

The entire State of Oregon is badly in need of rain, and unless it comes by June 1 serious damage will result, particularly to the grain crop. The power companies are preparing to carry heavy loads on steam during the late summer, as the present demand is heavier than ever before and the stream flow seriously short.

Building activity continues at a good pace, providing employment for a large number. A greater part of this work is confined to the construction of dwellings, with a fair percentage of larger buildings.

Wiring supplies are reported to be moving fairly well, and stocks are adequate to take care of the demand. Collections are somewhat slow.

Spokane

Business in most lines in this territory gives indications of a decrease, attributed to general conditions throughout the country. The output of the foundries and machine shops is normal, due to the excellent status of the metal mining industry, which is better than it has been for years.

The farmers are somewhat worried over the lack of rain. If it comes within two weeks, then splendid crops of wheat and fruit near Spokane are expected; otherwise severe losses will result, it is feared.

Permits for building in Spokane are above normal. There is a plentiful labor supply, due to an influx from the Coast. Movement in wholesale dry goods is slow. The public is reported to be buying automobiles and labor-saving appliances.

The Washington Water Power Company has completed its seven-week electric range campaign. During that period it sold in Spokane and other towns of the Inland Empire 406 ranges with a total valuation of $93,000.

Denver

No one factor has had the same effect in stabilizing present business conditions in this state as has the new oil development. Little or no wildcatting and blue sky promotion has evidenced itself. Eleven prominent companies have opened up large offices, and two of these firms are already producing oil from the structures pioneered by them. Realty values, building operations, and employment conditions are all ascending in the oil region principally adjacent to Fort Collins and Craig in the northwestern part of the state.

Other industrial activity continues to evidence itself, and in commercial lines the present program of expansion is without precedent. Two of the largest department stores of the city are enlarging their quarters as is also one of the banks, with another bank planning a twelve-story building. The telephone company is building a near-skyscraper.

In electrical lines, there is a normal condition with a slowing tendency in the sale of appliances, especially the smaller heating devices. Fans are taking up some of the gap. Building operations are keeping local contractors busy.

Salt Lake City

Resumption of seasonal out-of-door activities is providing additional employment, which naturally reacts favorably on business. The new $1,500,000 railroad shops of the Denver & Rio Grande Western in Salt Lake City are practically completed and will be opened shortly after June 1.

At the annual meeting of the Intermountain Association of Credit Men, held in Salt Lake City recently, there was a significant tone of optimism. Reports of various committees indicated an improvement in business during the past two years that was characterized as remarkable, with a forecast for continued improvement upon the harvesting of fall crops.

Agricultural activities are well under way, and suger beet acreage is materially increased over 1923. Metal mining continues active. The favorable outlook for metals, as well as the excellent physical condition of the mines, are factors which should operate to keep the mining industry in a thriving condition.

The Utah Power & Light Company is devoting intensive efforts to the sale of electric ranges, with excellent results. This program will continue throughout the summer and fall. While the season for hot-weather appliances is not yet well under way, electrical dealers are looking forward to some good business in this line.

Seattle

According to a detailed report compiled by the Seattle Chamber of Commerce, the first four months in 1924, as compared with a similar period of 1923, showed increases in building construction of 51 per cent; bank clearings, 12 per cent; postal receipts, 10 per cent; cargo tonnage passing over Seattle docks, 27 per cent; lumber production, 4 per cent. Retail and wholesale trade were fair and manufacturing active.

Lumber production is far below normal at present. Reports from logging interests of the Puget Sound district show a close-down of approximately 75 per cent from capacity operation.

Building continues very active, with home construction exceptionally favorable. Similar reports come from other Puget Sound cities, where construction has been heavy all of the present year to date.

Due to continued activity in residence construction, local electrical contractor-dealers report electrical work being maintained with a tendency upward and with prospect of continuance until well into the fall. Sales of housewiring devices, household appliances and electrical apparatus are good. Range sales in considerable volume are reported by both the city of Seattle and the Puget Sound Power & Light Company.

National Electric Light Association
Forty-Seventh Convention

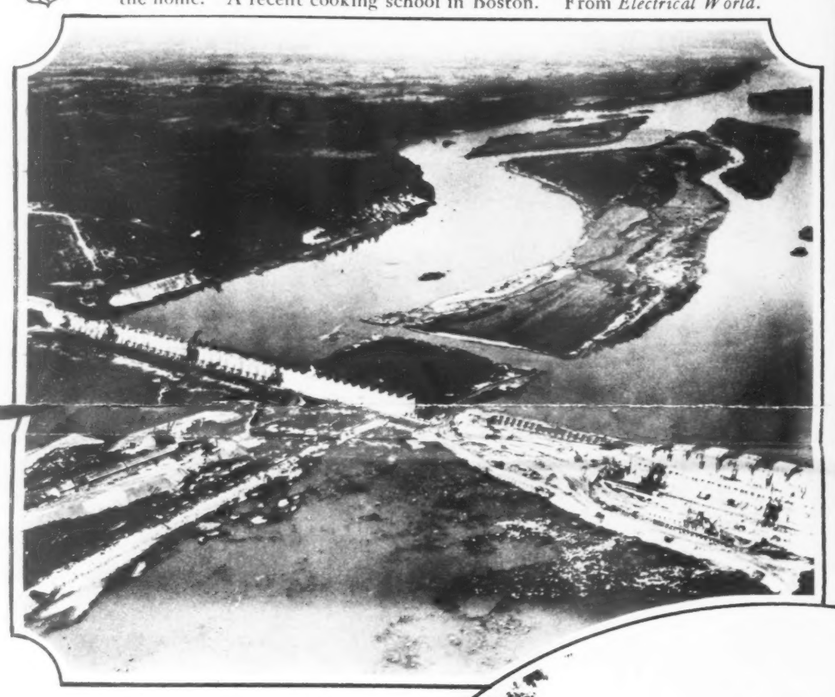
Journal of Electricity
In Two Sections—Section Two
June, 1924

Convention N.E.L.A. Pictorial

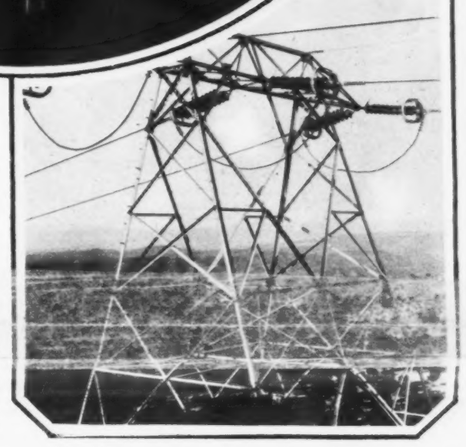
Incidents of the Year's Progress as Shown in Photographs—from the McGraw-Hill Electrical Publications

HOUSEWIVES LEARNING TO COOK—And proof enough that the American woman wants to know more about the uses of electricity in the home. A recent cooking school in Boston. From *Electrical World.*

THE SPIRIT OF ELECTRICAL MEN—Thomas A. Edison on his 77th birthday punches the clock as usual, because there is so much still to be done he can't take a day off. From *Electrical Merchandising.*

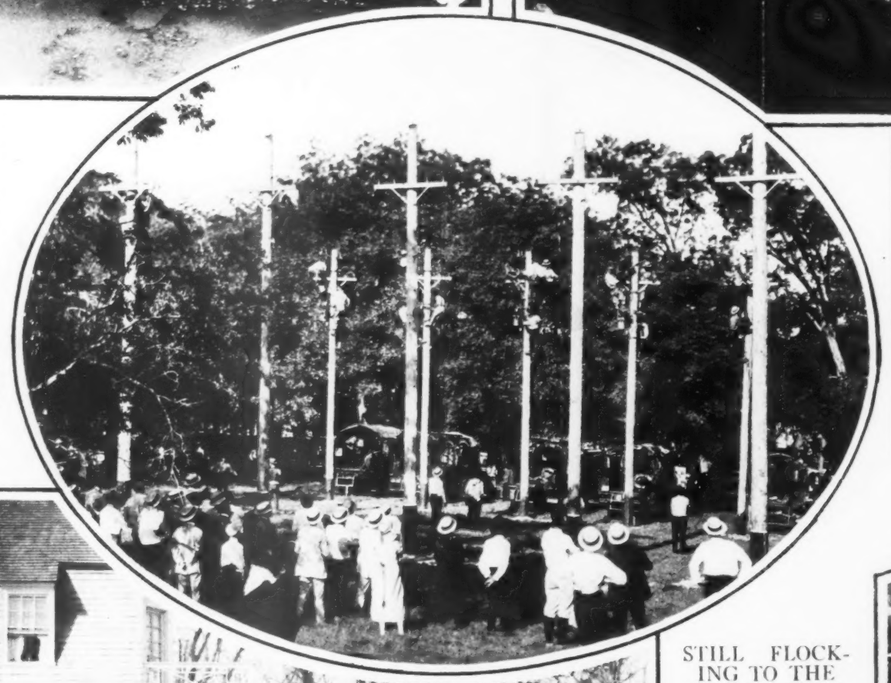


WATER POWER WAITING FOR THE WORD—Snoqualmie Falls, Wash., already partially developed. From *Journal of Electricity.*

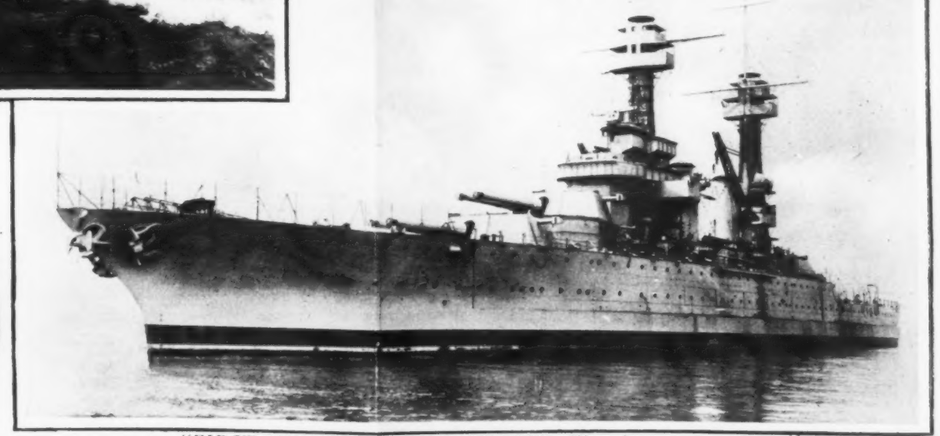


THE HIGHEST OF ALL "HIGH LINES"—A 220,000 volt transmission structure on a ridge of the Sierras in California. From *Electrical World.*

THE MOST TALKED OF WATER POWER IN THE WORLD—An airplane photograph of Muscle Shoals—in its present status of development, the prize for which the South and the farmer back Ford against the field. From *Electrical World.*



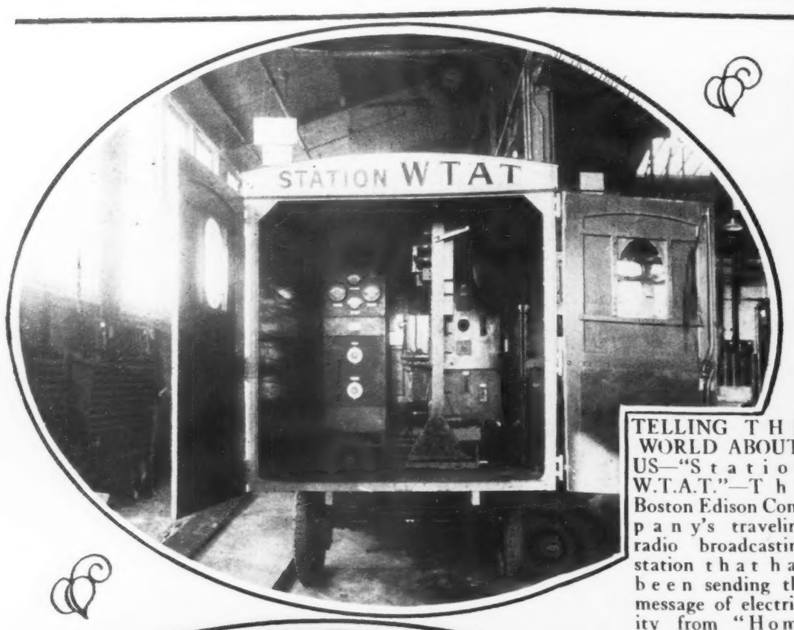
UPS AND DOWNS OF A LINEMAN'S LIFE—A pole climbing contest in Texas, staged at an outing of employees of the Texas Power and Light Company. From *Electrical World.*



"FIRST IN WAR, FIRST IN PEACE"—Electric power now drives Uncle Sam's strongest battleships. This is the newest ship the U. S. S. Colorado, costing $27,000,000. From *Electrical World.*

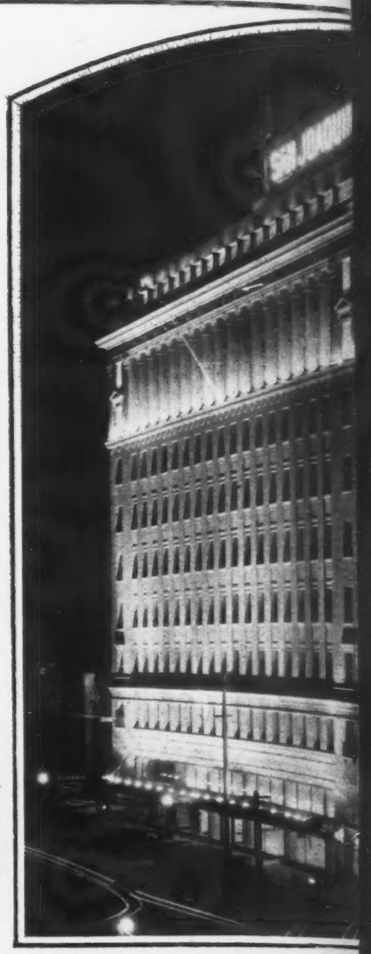
STILL FLOCKING TO THE "HOME ELECTRICS"—This one was in Worcester, Mass., where thousands went to study the uses of electrical appliances in the natural setting of a living home. From *Electrical Merchandising.*

WHERE WILLIAM PENN ONCE MET THE INDIANS—The Philadelphia Electric Company completes its Delaware Station. The first half was built of solid concrete during the war, when steel was not available. From *Electrical World.*

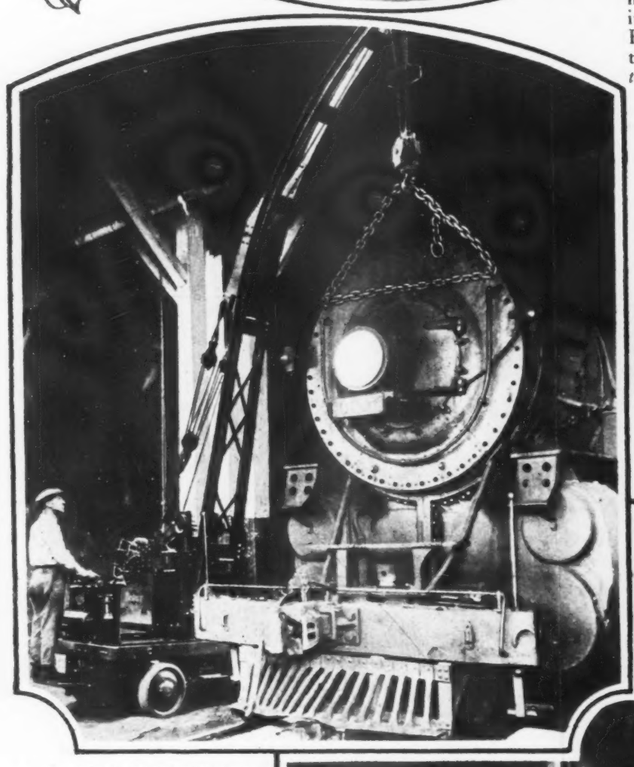


TELLING THE WORLD ABOUT US—"Station W.T.A.T."—The Boston Edison Company's traveling radio broadcasting station that has been sending the message of electricity from "Home Electric" demonstrations. From *Electrical World.*

THE CURRY COMB TAKES THE COUNT—Even the stars of the musical stage are now using electricity in their business. Edith Day, leading lady in "Wild Flower," grooms her leading donkey with a vacuum cleaner. From *The Home Electrical.*



LIGHTING A MONUMENT POWER—New Building of the S Joaquin Light and Power Co Fresno, Calif., a model utility he quarters with a splendid ground fl sales room. From *Journal of Electric*



PUTTING ONE OVER ON STEAM—A small electric industrial crane—a modern David and Goliath—hoisting up the [illegible] of one of the big railroad shops. From *Industrial Engineer.*

MODERN NIGHT LIFE AT THE COURT—Playing tennis by electric light in Southern California. From *Electrical Merchandising.*

TO LURE THE HUMAN MOTH—New Orleans resumes the Mardi Gras with more illumination than ever before. From *Electrical World.*

WHERE QUICKSILVER MAKES ELECTRICITY—The Hartford Electric Light Company's mercury vapor turbine, a radical departure in design that gives promise of some major economies in power generation. From *Electrical World.*

ELECTRIC TRUCKS PUT ON A SHOW ALL BY THEMSELVES—New York Edison Company turns the limelight on the electric truck by staging a Truck Show featuring street and industrial trucks, tractors and cranes, and a parade of 400 vehicles up Fifth Avenue. From *Electrical World.*

"What's the

To all men news is the spice
city has its eagerly read ne
tidings to the people. The
—the community of ele
and needs its news no less.
for electrical men is a va
today so perfected in its
great electrical publicatio
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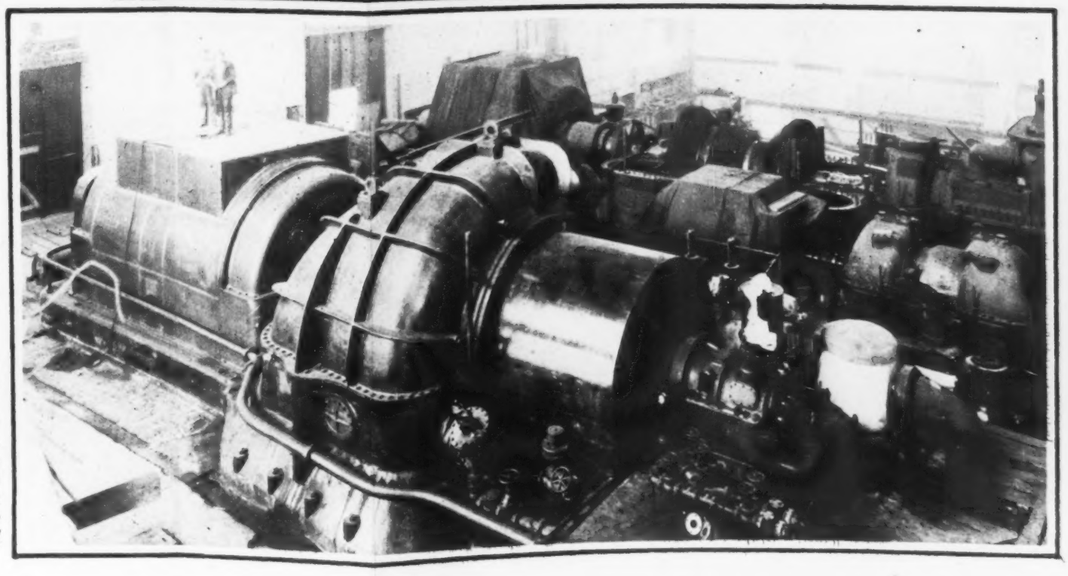
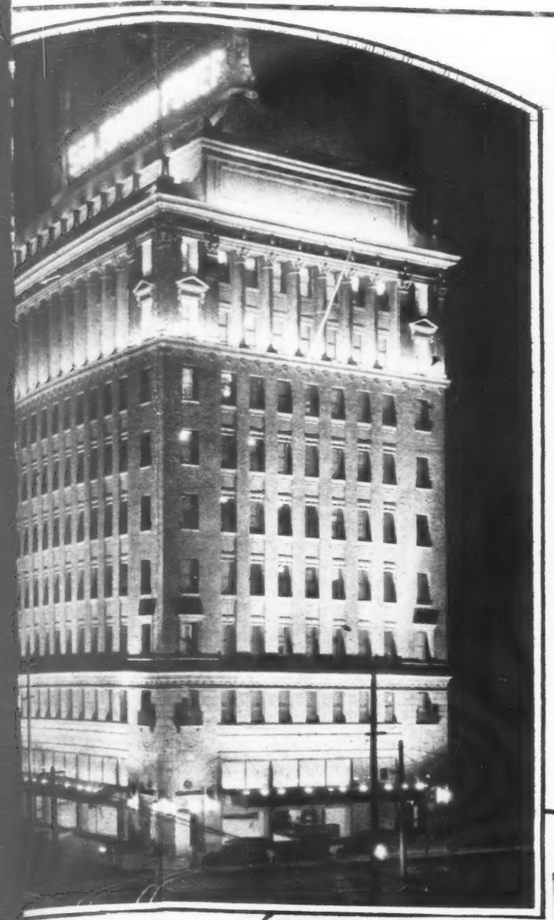
What is this news? It
recording of the things th

"UNTOUCHED BY HUMAN HANDS"—The New England Power Company's automatic station in Vermont.—*Electrical World.*

ADDING 30,000 RETAIL OUTLETS—The hardware dealer becomes an active advocate of "doing it electrically." From *Electrical Retailing.*

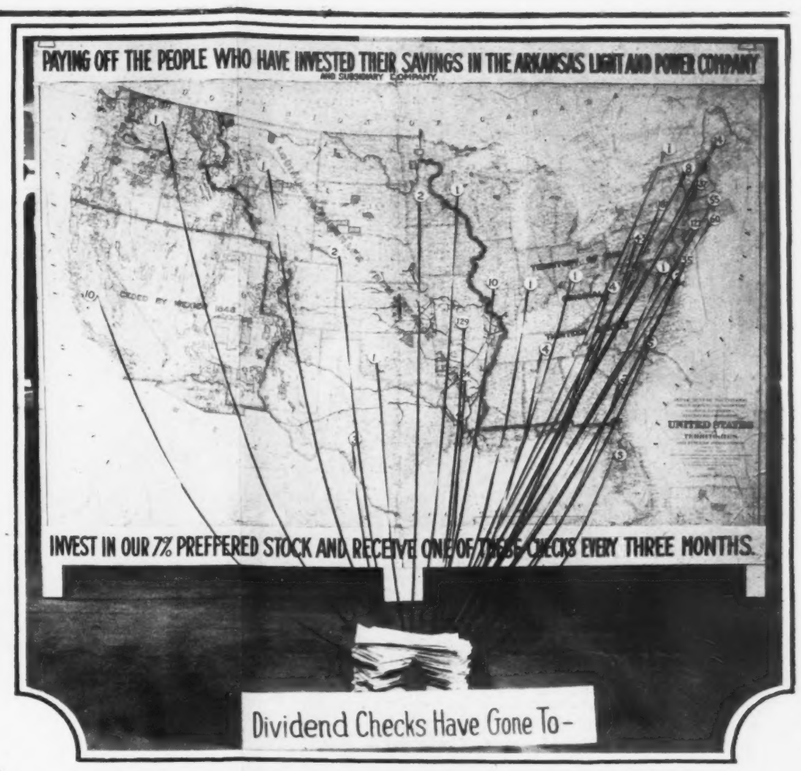
THE BIGGEST THING ELECTRICAL IN NEW YORK—New Hudson Ave. Station, Brooklyn, which will produce 400,000 hp. From *Power* and *Electrical World.*



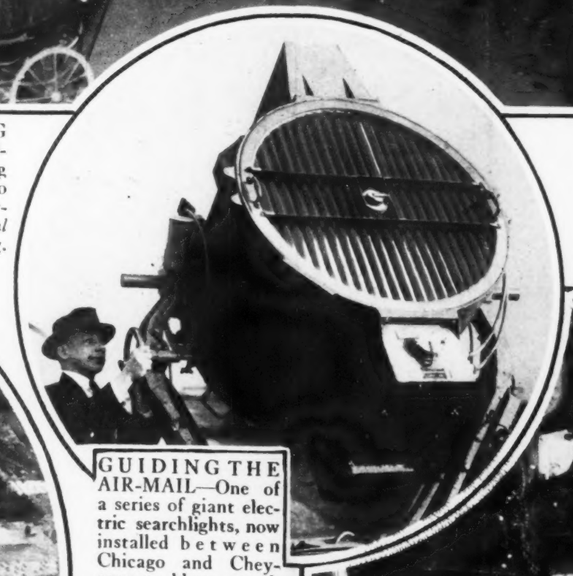


MONUMENT TO ... Building of the San ... and Power Corp., ... model utility head- ... splendid ground floor ... Journal of Electricity

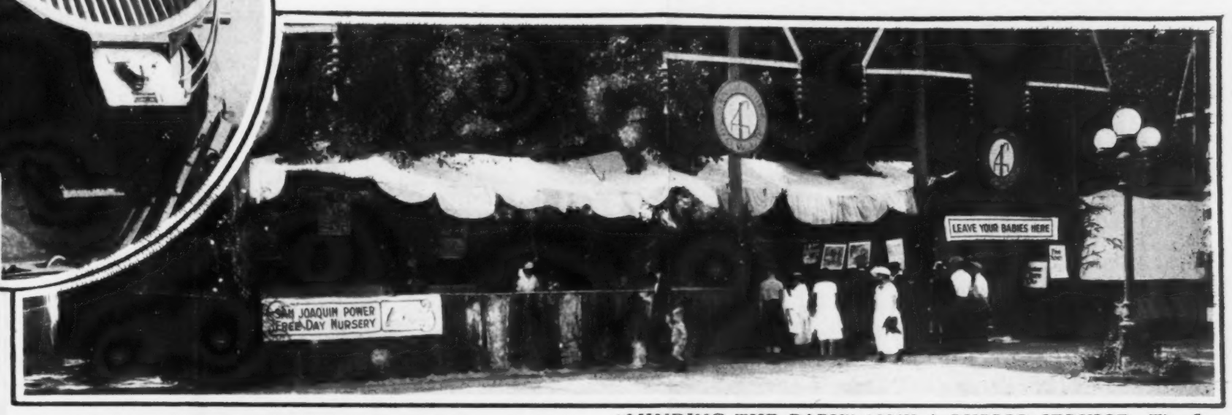
MAKING BILL PAYING A PLEASURE—Central-station customers paying their bills in a Chicago dealer's handy neighborhood store. From *Electrical Merchandising.*


PAYING OFF THE PEOPLE WHO HAVE INVESTED THEIR SAVINGS IN THE ARKANSAS LIGHT AND POWER COMPANY
AND SUBSIDIARY COMPANY
INVEST IN OUR 7% PREFFERED STOCK AND RECEIVE ONE OF THESE CHECKS EVERY THREE MONTHS.
Dividend Checks Have Gone To-

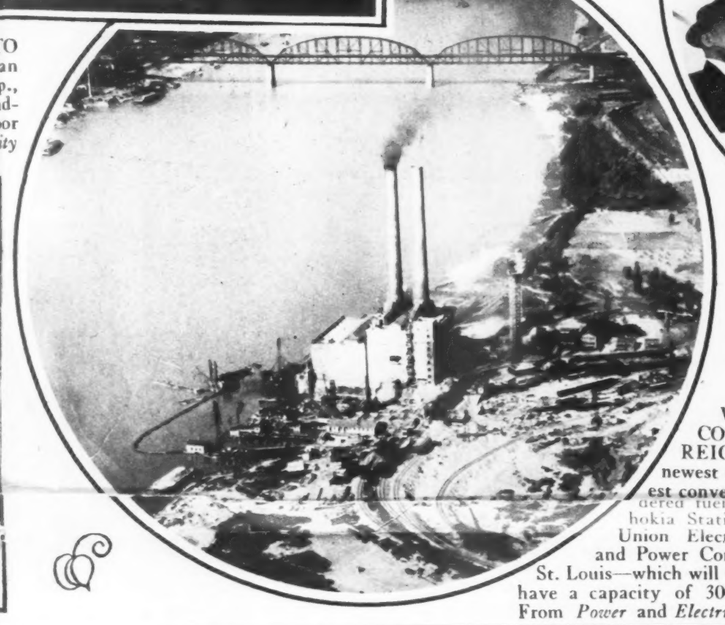
SHOWING WHERE THE PROFITS GO—Customer ownership grows as the public understands the central station better. This window tells the story in Arkansas. From *Electrical World.*



GUIDING THE AIR-MAIL—One of a series of giant electric searchlights, now installed between Chicago and Cheyanne to blaze a path of light for the United States Mail planes, making night flying possible.—From *The Home Electrical*

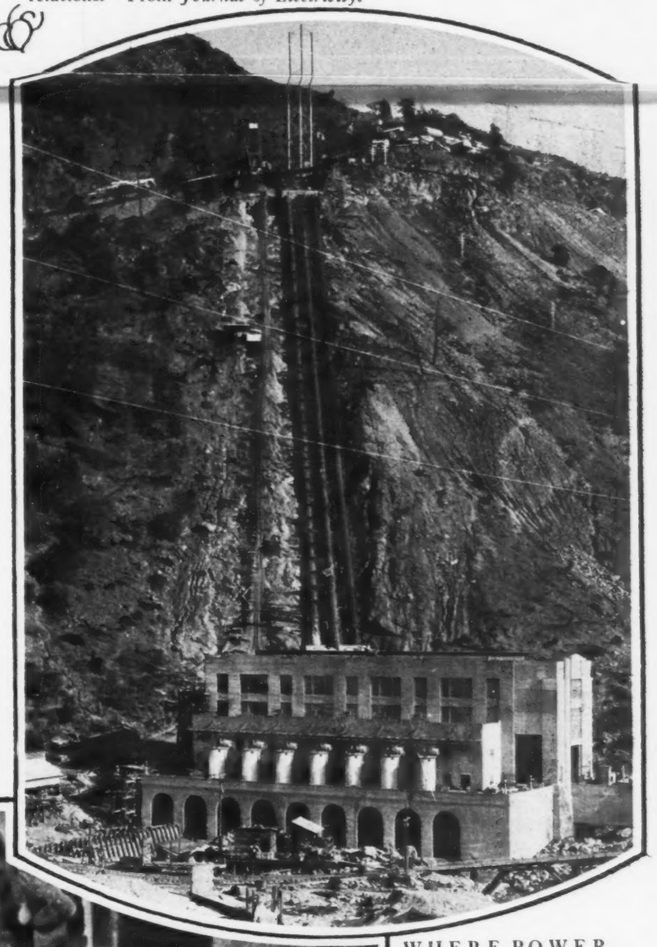


"MINDING THE BABY" NOW A PUBLIC SERVICE—The San Joaquin Power Company installs a Free Day Nursery at the State Fair and cares for several hundred kiddies—something new in public relations. From *Journal of Electricity.*



WHERE COAL DUST REIGNS—The newest and greatest convert to powdered fuel—the Cahokia Station of the Union Electric Light and Power Company, of St. Louis—which will ultimately have a capacity of 300,000 kw. From *Power* and *Electrical World*

ELECTRO MAH JONG CAFÉ A LA PERC—Olga Petrova, the famous Russian author and actress, now starring in this country in "Hurricane," turns from the ways of her mothers, and makes her black coffee in an electric samovar. From *The Home Electrical.*



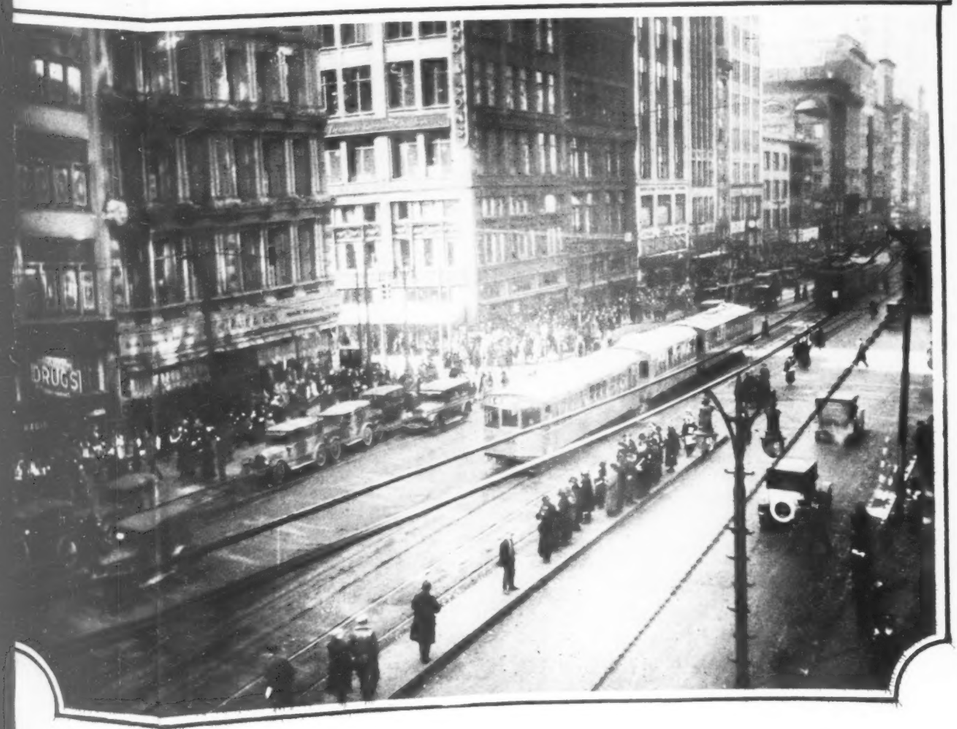
WHERE POWER ROLLS DOWN HILL—"Big Creek"—The famous hydro-electric development of the Southern California Edison Company, and virtually the heart of the power supply for the southern section of the Pacific Coast. From *Electrical World.*

hat's the News?"—says the Electrical Man

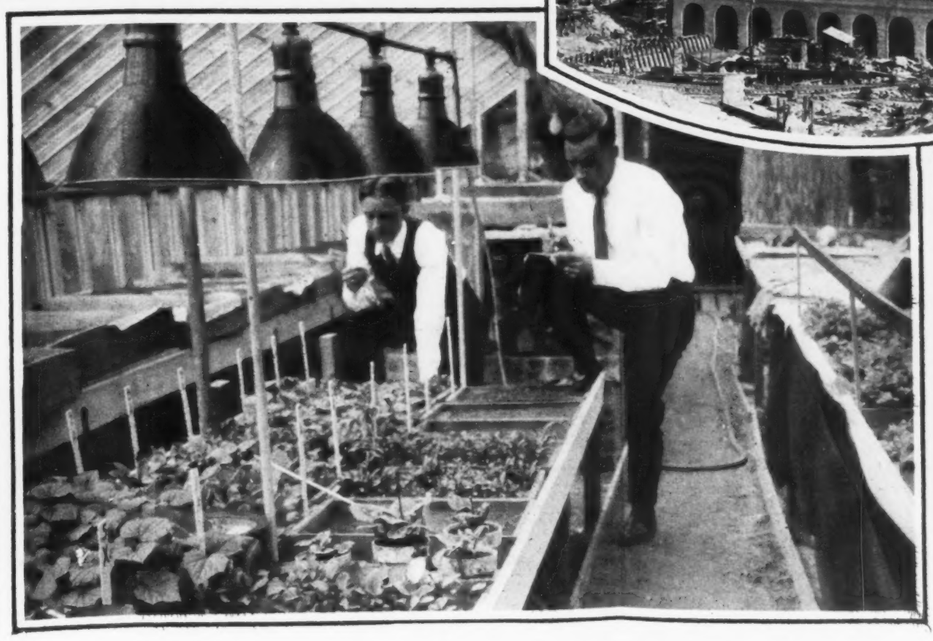
n news is the spice of daily life. Every s eagerly read newspapers to bring the the people. The industrial community mmunity of electrical men—desires its news no less. Gathering the news ical men is a vast enterprise and is perfected in its development that the trical publications have become hon- institutions of the industry.

s this news? It is the reporting and of the things that happen, the acts, the achievements and the events affecting electrical men of every kind throughout the world. It is also the interpretation of these acts and these achievements and these events and the opinions that men whose thinking is important, express about them.

The electrical industry looks to the electrical press to procure and provide the news. It relies upon it to present and preserve the written record of the experience and advancing thought of electrical men, the progress of this industry.



DETROIT TRIES SOMETHING NEW IN TROLLEY CARS—In spite of all the motor cars Detroit is traffic-bound like other cities, and has turned to three-car, four-truck, articulated street railway trains, taking power from a single trolley. From *Electric Railway Journal*



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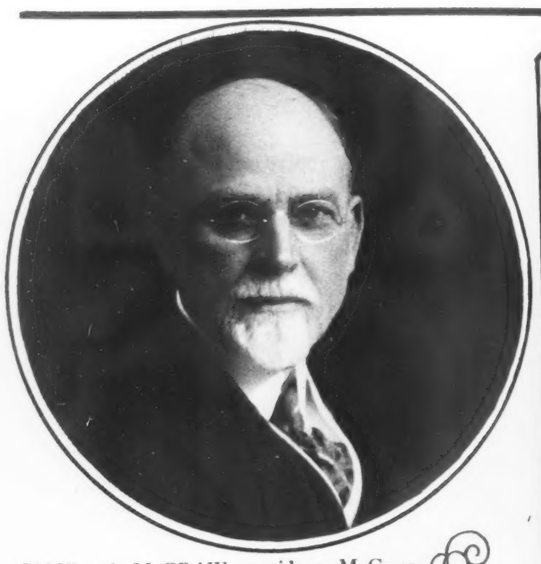
ELECTRICITY FOOLING THE FOLIAGE—An "electric hot-house" where experiments are being carried out in the artificial stimulation of plant life to develop a practical method of forcing vegetables and flowers for an earlier market. From *Electrical Merchandising.*



JAMES H. McGRAW, president, McGraw-Hill Company, and pioneer publisher of industrial journals, who has guided the principal papers of the electrical industry for twenty-eight years.

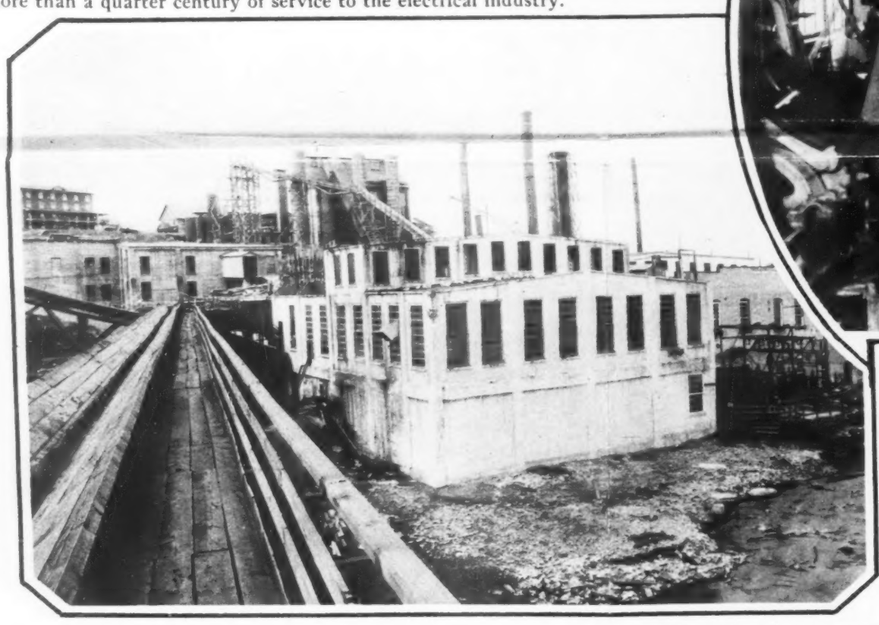
HEADQUARTERS FOR THE ELECTRICAL NEWS OF THE WORLD—Airplane view of the McGraw-Hill building, Tenth Avenue at Thirty-sixth Street, New York City, where four of the seven McGraw-Hill electrical papers are published.

WHERE THE COPY PENCILS ARE WORN OUT—One floor of the editorial and executive offices of the McGraw-Hill Company. Headquarters for fifteen McGraw-Hill publications.

THE MEN BEHIND THE PRINTED PAGE—Executive, editorial and business staffs of the McGraw-Hill Company gathered at a banquet in honor of two of their number, who recently completed more than a quarter century of service to the electrical industry.

NOT ONLY MAGAZINES BUT BOOKS—The office of the McGraw-Hill Book Company, the largest publishers of electrical, engineering and industrial books in the world.

TEN MILLION MAGAZINES A YEAR—A floor full of giant printing presses that day and night grind out the sheets that make up into the McGraw-Hill papers.



CASTING METAL INTO THOUGHTS—This bank of McGraw-Hill linotype machines, aided by the monotype and hand composition rooms, casts and sets the metal for approximately 25,000 column inches every week.

WHERE A LOG BECOMES A ROLL OF PAPER—The McGraw-Hill paper mill at Newton Falls, N.Y., where paper is made for fifteen McGraw-Hill publications that serve seven industries.

McGraw-Hill Service to the Electrical Industry

THE character and trend of electrical news has vastly changed in the last fifty years, since the *Electrical World* began to serve electrical men. The cumulative development of the multiplying applications of electricity has been steadily pyramiding not alone the news but the need for news. For no man's school-learning has sufficed him long in the face of the rapid evolution of electrical experience and opportunity.

With this growth has naturally come specialization. And the electrical press has trended with the times, expanding with the industry, until today there is a specialized paper intimately serving every important group of electrical men.

Beginning with the *Electrical World*, the earliest electrical industry publication, the progress of electrical development has been marked by the successive appearance of five other McGraw-Hill electrical journals to lead and serve in some definite field. They are—

Electrical World—Published weekly, the "master" executive and engineering paper, the weekly newspaper of the electrical industry, written alike for the central station man, the electrical engineer, the electrical manufacturer and jobber, and the large contractor, reflecting broadly the activities, problems, opinions, and progress of all groups of the industry.

Electric Railway Journal—A weekly, devoted entirely to the service of those electrical men who are engaged in the street railway industry.

Electrical Merchandising—Issued monthly to the commercial executive, appliance sales manager and salesmen of the central station; the electrical dealer and contractor, and the manufacturer and jobber of appliances, lighting equipment and wiring materials.

Electrical Retailing—A pocket-size monthly paper for the non-electrical merchant who sells electrical appliances as a profitable sideline.

Industrial Engineer—A monthly, talking directly to the men of the large industrial works of the country, describing and discussing the operation and maintenance of electrical and associated mechanical equipment.

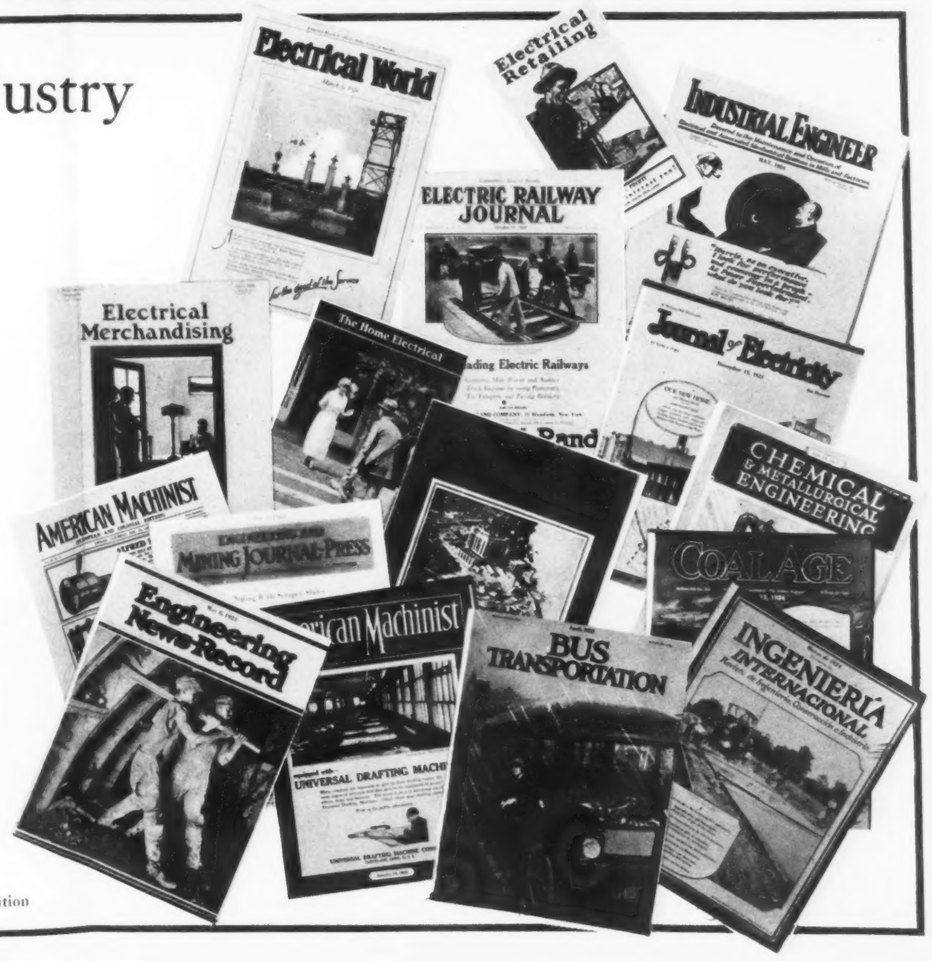
Journal of Electricity—A semi-monthly publication specifically edited for the great electrical community of the Pacific Coast as its local electrical industry paper.

And with these should be also mentioned—

Power—Although not an electrical paper, it devotes space each week to practical electrical problems of the industrial and private plant, written for men who have come up through the steam end of the business.

The Home Electrical—A small pictorial telling the popular story of electricity in modern living, for distribution to the customers of central stations and dealers.

Every one of these publications has sprung from the industry itself in response to a need and a demand. For the electrical press is an institution of the electrical industry, established and supported by the industry for the dissemination of information to electrical men. Without the knowledge that comes to electrical men through the electrical press—through these McGraw-Hill electrical papers—the electrical industry could not have grown to its present greatness. Unless this electrical press continues to serve electrical men in accordance with their changing needs, the industry cannot hope to realize its great future.



McGraw-Hill Company, Inc., Tenth Avenue at Thirty-sixth Street, New York

James H. McGraw, President

Electrical World
Electrical Merchandising
Electric Railway Journal
Electrical Retailing
Journal of Electricity
Industrial Engineer
American Machinist
Engineering News-Record
Ingeniería Internacional
Engineering and Mining Journal-Press
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